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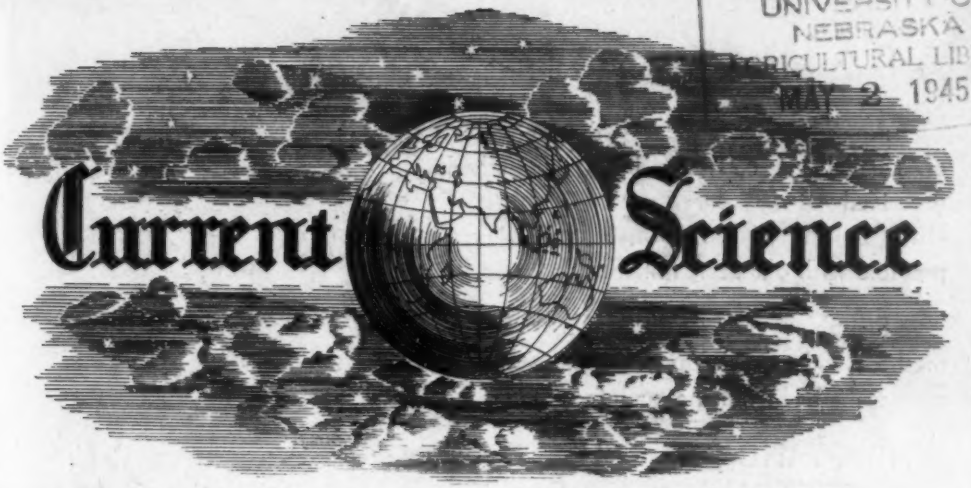

Vol. 14, [illegible] JANUARY 1945 Pages 1-26 343

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CURRENT SCIENCE

Vol. XIV] JANUARY 1945 [No. 1

	PAGE
Give Science a Chance	1
The New Oil Committee and Fundamental Research. P. RAMASWAMI AYYAR	5
Influence of Mercury on Insect Eggs—Pt. I. BY B. KRISHNAMURTI AND M. APPANNA	7
A Chlorosis of Paddy (Oryza sativa *L.*) *due to Sulphate Deficiency.* BY S. P. AIYAR	10
New Year's Honours	11
Zoogeographical Divisions of the Western Ghats, as Evidenced by the Distribution of Hill-Stream Fishes. BY B. S. BHIMACHAR	12
Magnetism in Relation to Structure. S. V. A.	16
Letters to the Editor	17
Centenary of Sir Patrick Manson	23
Reviews	24
Science Notes and News	25

"GIVE SCIENCE A CHANCE"*

INTRODUCTION

AFTER referring to the sad loss which the country has suffered by the death of Acharya Ray, Sir S. S. Bhatnagar described the visit of Prof. A. V. Hill as "Perhaps the most outstanding event in the scientific life of India during the past year". The invitation to Professor Hill extended by the Government of India has been generally taken as an indication of their interest in securing the aid of science to problems of national development to which they are committed during the post-war period. It was largely owing to the insistence of the Council of Scientific and Industrial Research that more financial aid should be given to science, that such an invitation could be conceived even during the war.

Proceeding, he said, "It is a happy augury that the report made by Professor Hill had an unusually short incubation period. Following his recommendations the Government of India have already created a Department of Planning and Development and the Council of Scientific and Industrial Research has been transferred to this portfolio. Other research activities under the Government are likely to follow suit. I am sure the scientists assembled here have special reason to be happy in the fact that the choice of the Viceroy for the care of this new portfolio has fallen upon Sir Ardeshir Dalal who has been a past-President of the Indian Science Congress and who commands the confidence and respect of the scientists as well as of the business community of India. It is hoped that other far-reaching recommendations of Professor A. V. Hill will also be accepted by the Government of India. There is no better method of raising the standard of science and scientists in this country than that so ably developed and skilfully described in his address before the last session of the Indian Science Congress.

"Another direct outcome of Professor A. V. Hill's visit to India has been that a mission of scientific workers from our country has been touring the U.K. and has arranged to go over to the U.S.A. and Canada, to observe the scientific, industrial and agricultural developments which have come about in these countries during the war and then to make recommendations and suggest plans for a further interchange of information and knowledge for mutual help and co-operation. India has been cut off intellectually for more than five years from the rest of the world and that in itself is a disaster the magnitude of which is directly proportional to the vast strides science and research have made in the U.K. and the U.S.A.

"My present visit to England has been the greatest eye-opener to me and I have now seen with my own eyes the high levels to which scientific invention and ingenuity have risen during the war. Not only has science helped

* Extracts from the Presidential Address by Sir Shanti S. Bhatnagar, Kt., O.B.E., D.Sc., F.R.S., to the 32nd Annual Session of the Indian Science Congress, held at Nagpur, on 2nd January 1945.

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in developing weapons and instruments which are essential for success in a mechanical warfare, but it has aided industry and agriculture in supplying the basic needs of humanity during a period of great difficulty. The results both in military and human terms have been most encouraging. The large-scale application of radio-location, the jet-propelled planes, the numerous types of jettison tanks and unbreakable containers, the automatic weapons of offence and defence and scores of new alloys and novel metallurgical processes have had far-reaching consequences on the course of the war. The technique of operational research, the use of scientific methods of determining tactics and developing a national food policy, the discovery of penicillin and D.D.T., all these have contributed much to the realisation by the common man and the Government that organised science is one of the most important factors in national development. It is a tragedy that a ruthless war and almost universal bloodshed should be necessary for this new awakening, for it should have been obvious without it that science can play and must play an essential part for human advancement. In fact, unless opportunities are provided for science to explore these possibilities for human betterment, a better world cannot be created.

"There is no doubt that England is sparing no effort to approach the Peace much better informed and equipped than after the last War and the signs of this new awakening are visible in the universities, the Government departments, in industry, the agricultural and medical institutions and in every other walk of life."

Science in the British Universities

"We found most Universities denuded of their ablest workers. They were nearly all engaged in important war work and visited their departments only occasionally. They were busy with meetings and committees and in special scientific work related to the war-effort: but all the same they are all devoting their attention to the future of science in British Universities. The Association of Scientific Workers has submitted a memorandum to the University Grant Committee of the Treasury suggesting what reforms in teaching and research should be taken in hand immediately after the war and better provision for science should be made in the universities. Their report ends with the following strong plea:

'We reiterate, then, our plea for the utmost vision and flexibility in budgeting for the development of science in the Universities. Where the flowering of intellect is concerned, any accurate prediction is impossible. We are convinced, however, that peace can see at least as rapid a growth in all fields of science as war has brought about in some special applications. The only proper attitude for an enlightened community is to make available the financial and material resources appropriate to each stage of development. We are far from being in sight of either the fruits of science or the end of our reserves of intelligence. Bold and flexible thinking is, therefore, the prime necessity in framing post-war policy for the universities.'

"Out of the many important recommendations made by the Association of Scientific Workers for the expansion of scientific activities in the universities, the following are quoted so that the Indian universities may take a lesson from what is now the train of thought in Great Britain:

(1) Schools of fundamental research must be fostered in the universities, expansion proceeding as fast as talent appears.

(2) All graduates with an aptitude for research should be offered full maintenance while working for a higher degree.

(3) Research fellowships should be provided for those who have taken a Doctorate degree.

(4) When men are appointed mainly to do research they should have the same status and salary as those appointed mainly for teaching.

(5) Research committees should be set up in every university to watch over the development of research, especially in borderline subjects, and prepare an annual research budget.

(6) The education and training of laboratory techniciaris should be given immediate attention. Courses should be planned for general education and technical training.

(7) The wages of technicians must be revised upwards forthwith if the universities are to attract the right type of personnel.

(8) Centralised technical services and supplies for research should be established in each university. These should include facilities such as a typewriting pool and a statistical service.

(9) Departments of applied science should be brought into being, as they are bound to play an important part in the university.

(10) Industrial development work should be carried out in Research Association laboratories: but where these Research Associations do not exist the university laboratories may be employed.

(11) Academic scientists should be allowed to act as consultants or advisory directors of research to research associations and should be given leave to spend long vacations in industrial laboratories.

(12) Properly supervised research in selected Research Associations and Government laboratories should be allowed as part of or a full qualification for a higher degree.

"Some of these recommendations involve capital cost and the memorandum referred to above estimates this to be not less than £30 million over a period of ten to twenty years. The actual expenditure of the universities would rise to £15 million per annum within five years and to £20 million over ten years at 1939 values. It has been suggested that most of this money will come from the State. Further, it has been strongly recommended that the Treasury Grant to the Universities should be doubled in the first academic year after the war and increased to quadruple, that is, to £9 million, in the fifth year.

"The future of science in the British Universities would thus be assured. This must serve as an incentive to our Vice-Chancellors who should ask the nation and Government for more grants for technical education and developments of sciences in the Indian universities. I have been told that at least in two Universities in India, scientific research is now positively discouraged and (in the name of economy) admission to research students, in spite of the willingness of the professors concerned, is almost completely prohibited. I take this opportunity of drawing the attention of those who love their country and wish it well to see that the field of University education is kept as free from narrow communalism and politics as possible. Since politics has begun to play a part in the selection and election of Vice-Chancellors, the University standards in India have tended to deteriorate instead of showing an improvement and if these evils are not looked into by the Chancellors and the Courts of the Indian Universities, these institutions will cease to be real seats of learning and will turn into arenas for political ambitions."

Science in British Industry

"British industry in the past relied too much on tradition. It is now realised that the prosperity of Britain after the war will depend as never before upon the efficiency and progressiveness of her industries. Happily, for it is a most healthy indication of things to come, industrial and scientific research, is on almost everyone's lips now-a-days and it is certain that this will be one of the major features in post-war industry. In certain industries, such as the chemical industry, the application of science and research has reached such high levels already that even the Department of Scientific and Industrial Research has not considered it an imperative necessity on their part to equip and maintain their Chemical Research Laboratory to the same level of efficiency as their National Physical Laboratory. They maintain that the Imperial Chemical Industries conduct research on such a large and liberal scale that the Government Laboratories need not compete with them. The Directors of the Company are progressive in their views on scientific development and at a luncheon which the I.C.I. gave to the Indian scientists at Claridges, Lord McGowan, the Chairman, reported that the Directors of the Company had offered to provide at nine Universities of Great Britain, eighty fellowships of the average value of £600 per annum to be held by senior workers in certain sciences. The research organisation of the Company itself consists of nearly nine hundred fully qualified chemists, physicists, biologists, engineers and other scientific men and more than a thousand skilled assistants. During 1943 its expenditure on research and development in its own work was approximately £2,200,000; and in addition, £12,500,000 became due from the Company to the British and Overseas Governments under the heading of Excess Profits Tax, National Defence Contribution and income-tax. We had the good fortune to see their vast factories and research organisations at Bellingham, Blackly and Huddersfield, and our distinguished industrialists who are visiting England should go and see these signs of research-mindedness of the British Industries.

"When I replied to the toast proposed by Lord McGowan at the luncheon, I spoke of the I.C.I.'s partiality to their own country. They had at least two big factories in India and I pleaded for grants on a generous scale for scholarships for scientific research in India by the I.C.I. I urged that no feast given to the Indian Brahmins is complete without a gift, and that all scientists are Brahmins by profession. The plea went home to Lord McGowan and he promised to consider in a friendly way the question of endowing research fellowships in Indian Universities. He also assured us that the eighty fellowships in the British Universities were open to Indian scientists in free competition.

"Besides the I.C.I., there are other industries in Britain which have large research departments, and we were particularly impressed by the efforts which had been made by such firms as Metropolitan Vickers at Trafford Park, Manchester, by the General Electric Company at Wembley, by Burroughs Wellcome, by Brown Firth & Co., by the B.T.H. at Rugby and by the Anglo-Iranian and Shell group organisation. In addition to the many private investigations carried out by individual firms, the interests of research by industry are safeguarded by investigations carried out in twenty-four Industrial Research Associations, which are maintained jointly by Industry and the Department of Scientific and Industrial Research."

"We are aware of even more outstanding organisations of this kind in the U.S.A. and Canada and look forward with eagerness to visiting the Bell Telephone Laboratories in New York in which the American Telegraph and Telephone Company employ over 4,000 scientific workers and technical men. The General Electric Company at Schenectady, N.Y., the Eastman Kodak Company at Rochester, N.Y., the Mellon Research Institute, Pittsburgh, and the various Petroleum Companies in the U.S.A. have fully equipped laboratories which work day and night on problems of fundamental and applied interests.

"If Indian industry has to rise, and rise it must to its proper stature in time, it must begin to devote more attention to expenditure on research. There is hardly any industrial organisation in India except Tatas which provides even reasonable facilities for scientific and industrial research. Lately Mr. G. D. Birla and Sir Shri Ram have shown some interest in scientific research, but much has yet to be done by science to save the existing industries in India from extinction by outside competition after the war.

"The newly started industrial units of India should join together and form Industrial Research Associations and the Council of Scientific and Industrial Research and the Government should subsidise the organisations so that they may blossom forth into hopeful industries of the future India.

"Now that expenditure on research, both

capital and recurring, is likely to be free from the Excess Profits Tax, Indian industry should give a real impetus to science. Nothing will help industry and science more than if our firms in India become research-minded. Even before my visit to England I strongly advocated the formation of Research Associations in India and I am glad to hear that the chemical and pharmaceutical industries of India are about to give a lead in this matter and have apprised the Council of Scientific and Industrial Research of their intention to form a research association. After seeing the work of Research Association Laboratories here, I have become convinced that we must work hard to get our small and big industries in India research-minded so that they may gain knowledge and strength to produce goods of the best quality and performance."

Industrialisation of India Essential for World Progress

"Perhaps the most important factor which will have world-wide implications will be our attempt to raise the standard of living in India. Politics does play an important part in all events. It is obvious that the best and quickest way of bringing about national development is for India to have a National Government representative of the people. The present absence, however, of such a government does not justify that the thinking men and women of India should not devise ways and means of bettering the lot of their fellow-beings to the best of their ability under present circumstances and in view of the future. I am not convinced that the rich and the wise in the land have done all they can for agricultural and industrial development of India.

"It has been urged by some that the problem of India is largely biological: that health, food and population are our real bottle-necks. Those who know India intimately are fully aware of the facts that attention to agriculture alone cannot solve the problem of India's poverty. Biology must be helped by physics, chemistry and engineering, even by mathematics. India cannot be healthy, prosperous and self-respecting, and education, medicine, and agriculture cannot play their important role, unless a good bit of India's population is devoted to pursuits other than agricultural.

"In a previous paper I have described the orders of priority for some of the industries essential to India's development. In that paper the first place was given by me to the development of power and there seems to be now a general consensus of opinion that India must develop her hydraulic and other power resources as her coal resources are already severely strained. This project will have to be largely financed by the State, as it is far too big for any private enterprise in India. The State will also have to help big basic industries and heavy engineering. We should, by all methods of persuasion and even threats, appeal to the existing industries in India to develop the bye-products industries associated with them. For example, the great jute industry in India should take immediate steps to manufacture such things as jute-boards, Brattice cloth, jute felt from jute waste, jute containers and jute cloth for wearing purposes. The State and the public should insist upon these industries being developed by the jute industry itself. Similarly it should be the duty of the sugar industry that their bye-products such as molasses and bagasse should not be used wastefully as at present. Power alcohol, furfural and its derivatives, acetic acid and all sorts of plastics and solvents can be made from these bye-products and these should occupy the immediate attention of the promoters of our sugar industry. They have sufficient money to invest in these ventures which may not start paying dividends all at once, but they will eventually be all very worthwhile in national planning and development. If I would not be misunderstood, I would make a suggestion to those European and Indian friends who are interested in the industrialisation of India not to fight for less or more to either side, but to come to terms honourable for both and do something to help Indian industry. It is obvious that European friends in India will have to yield to the natural aspirations of India, namely, that industry in India should be largely managed by Indians themselves. Indian businessmen should see that co-operation with the allied powers is the quickest method of developing India. The energy spent in fighting may be better spent in co-operative development. If the bye-product industries of coal-distillation, the petroleum industry, the textile industry, the woollen, cotton, sugar and jute industries and the metallurgical and chemical industries are developed, the country will have a different complexion altogether and a co-ordinated programme of development in all directions will become a possibility. This plea I am entitled to make as President of the Indian Science Congress, as I am convinced that science has no future in India unless our agriculture and our industries are fully developed; more food and more health are dependent upon these factors. Scientific and industrial research thrives best when it is applied to material benefit to human kind and to existing industries and existing agricultural enterprises."

Training of Personnel

"As a result of our visit it may be possible to persuade the Government to have scientific liaison officers in Washington and London, and possibly in Moscow, so that the Indian scientists and the Indian Government departments may be in touch with the rapid strides which Science and Technology are making in these countries. These offices will have to be staffed by scientific men of some standing in India. It is also likely that we may be able to get admission for a large number of scholars and technicians from India both in the Universities and industries. We found many Universities eager to have good students for post-graduate studies. Lord Eustace Percy was particularly anxious that good-class Indian students should take advantage of medical and dental studies in their well-equipped faculty of medicine at Newcastle. Similar assurances were given to us by the authorities of Cambridge, Oxford,

London, Sheffield, Leeds, Glasgow and Manchester Universities. There will be a great paucity of space immediately after the war in these places of learning, but they hope to have a great deal more space later on. We should increase the availability of technical talent in India by sending our young and brilliant students to England and America. India needs not only scientific researchers but also technicians—persons of the foreman type who can help in the running and repairs of machinery so essential for industrialisation. Such firms as the Imperial Chemical Industries, Metropolitan Vickers and the non-ferrous metal industries in England are quite willing to train young men from India and even pay them as apprentices; we need a very large number of men with these qualifications, and we shall have to look for such training in Canada and the U.S.A. as well."

Factory and Farm

"In England great emphasis is being laid on equalising the standard of life in the cities and the villages. Agriculture still retains in England too much of its primitive character. Modern methods of application of energy on the farms, conditioned transport and proper storage of agricultural produce are still in their infancy. Canada and the United States are ahead in this field and the tractor, the motor vehicle and electric power have contributed a great deal in those countries for a better standard of life on the farm. On a value basis at present about 88 per cent. of the world's agricultural produce is used as food, 8 per cent. as textiles and 4 per cent. for other industrial purposes. The last two together form roughly one-third of the raw materials of industry. There is an increasing tendency to look to agriculture for a larger proportion of these raw materials, but these materials can only be used profitably if the factory becomes an adjunct of the farm. Industry is moving towards that ideal particularly in the U.S.A., and this may be a lesson which we in India may learn in our planning for the future. We are so primitive in our farming that this would be an idle dream unless we first improved our transport and communications and provided better methods of storage and marketing, power-driven machinery and the use of proved fertilisers."

Concluding the President described the Tennessee Valley enterprise as "the romance of a wandering and inconstant river, now become a chain of charming and lovely lakes which have contributed much to the enjoyment of life of the people, on which move, without any dangers of accidents, barges of commerce which nourish American industries. It is a fairy story of wild waters controlled by human ingenuity creating electrical energy which has been America's Alladin's lamp. I dream of the Tennessee Valley, but not without hope: for all this may happen to any river valley in India to the Damodar, to the Ganges, to the Sutlej, to the Narbada, to the Sone, if the people and the Government just give science a chance."

THE NEW OIL COMMITTEE AND FUNDAMENTAL RESEARCH

IT is a matter for sincere gratification and happy augury for the future welfare of the millions of this country that the Government of India Member for Health, Lands and Education should have recently declared his firm conviction before an assembly of the representatives of trade and commerce at Madras, that the promotion of the health and education of the people and the development of the resources of the country are of "greater importance than political problems". This advice and the appeal made by Sir Jogendra Singh, himself a producer, to an assembly of commercial magnates is none too early at the present juncture of our national economy. In any self-governing country, the merchant class should consider themselves not only as the privileged distributors and trade agents of the national produce but should also act reciprocally as the enlightened patrons promoting the cause of the producers. Production requires not only the capital of the business-man but also the wholehearted co-operation and contribution of the skilled technician and of the research scientist.

The idea of creating commodity committees and making them self-supporting to carry on research and have their own services throughout the country is an extremely useful and creditable suggestion. Among such commodities, the position of oil-seeds is a very high one indeed.

Not long ago *Current Science* had an editorial on this important subject putting in a strong plea for the scientific utilisation of Indian oil seeds. After a period of nearly two years it is encouraging to find that publicists have paid attention to the points urged therein. It is well known that oil seeds form a valuable part of the annually recurring agricultural wealth of this country. Out of a total area of 300 million acres under actual cultivation about 60 million acres are under oil-seed crops. Further the 90 million acres of Indian forests also yield as minor forest produce, commercial quantities of important oil seeds. The more abundant of these are listed below for convenience of reference.

Oil-seed	Area in millions of acres	Output in millions of tons
Cotton	25·0	2·0
Groundnut	10·0	3·3
Mustard and rape group	7·0	1·0
Linseed	5·0	0·5
Gingelly	5·0	0·6
Castor	2·0	0·2
Cocoanut	1·4	1·4
Poppy	0·5	0·2

The less abundant but nonetheless valuable commercial oil seeds comprising mowra, niger-seed, safflower, kokum, domba, dhupa, chaul-

mogra, neem, ritha, cashew, honge, kusum hemp and many others add to a total of about 10 million tons of oil seeds, approximately valued at 100 crores of rupees. The proper utilisation of this precious raw material not only in the best interests of the agriculturists but also in the interests of landless labour and the educated unemployed, is a responsibility which no enlightened government or patriotic business-man can shirk. A unique feature of oil seeds is their potential as well as actual utility for a variety of the essential needs of man, machine, livestock, and soil, as foods and drugs, as fuel, as fodder, as fertiliser, and for a variety of other industrial purposes.

A rational plan of utilisation of these oil seeds will naturally resolve into a systematic assessment of the scientific value and the industrial potentiality of the three components into which they may conveniently be separated: (1) The shells and husks of the oil seed, (2) the oils and fats derived from the kernels and (3) the residual oil-cakes. Each of these forms a valuable starting material from which a succession of industries could be built up. Taking first the most important components of them, *viz.*, the oils and fats, one need only peruse the following list of their industrial uses for realising their vast and varied importance.

(1) Refined salad and edible oils, including hydrogenated vegetable ghees, (2) toilet, textile and liquid soaps including Turkey-red oils, (3) illuminating oils, candles and liquid fuels, (4) glycerine and explosives, (5) paints, varnishes, lacquerware and plastics including rubber substitutes, (6) shoe and leather-dressing greases and polishes, (7) simple and compound lubricants, (8) linoleum and water-proof fabrics, (9) medicinal oils and pharmaceutical compositions, (10) various fine chemicals including valuable synthetic perfumes.

Each one of these uses has led to the development of a special branch of oil technology. The progress attained so far in each of these, however, has been based chiefly on imitation of experience gained outside India, and as such suffers from being too wooden and static to inspire continuous research on them so as to ensure a progressive efficiency and economy. For example the oil hardening and vegetable ghee industry has factories all over the country where some of the foreign formulæ are imitated in specially imported foreign machinery, affording neither incentive nor encouragement to creative research in this field of chemical industry. For instance other catalysts than nickel can certainly be found to effect hydrogenation of oils. To take another example, other oils than castor may be treated so as to yield Turkey-red oils. Again, satisfactory liquid fuel for lamps as well as for engines can be made from cheaper vegetable oils by suitable cracking processes or by other chemical treatments. Another important branch of oil technology in which commercially valuable results are possible by systematic research is the production of candle material and wax substitutes from most of the common oils by special hydrolytic or oxidative methods. In a similar way many common semi-drying or non-drying oils like castor oil or even groundnut oil can be converted by oxidative and dehydration methods into linseed oil substitutes for the purpose of the paint and varnish industry. In fact the scope for fundamental research leading directly to results of industrial value is almost unlimited in every branch of oil technology. The above examples are only a few illustrations of such possibilities.

One of the most attractive and in the writer's opinion the most outstanding contribution which applied chemistry can make to oil technology will be the establishment in this country of a genuine synthetic ghee industry. It will be an achievement alike for the chemist, the technologist, the industrial captain, and the administrator if they will co-operate through an industrial research laboratory to make this a commercial success. It will mean firstly the establishment of a fatty acid key-industry employing either fermentation methods of hydrolysis of oil or the more drastic hydrolytic methods of oil splitting by caustic alkalis or mineral acids. In both these cases glycerine liquor will be a concomitant bye-product, and the production of pure glycerine from this bye-product will be the second stage of the future synthetic ghee industry. The third stage will consist of the esterification with pure glycerine of the various fatty acids mixed together in the right proportion as found in genuine cow's ghee or buffalo-ghee or goat's ghee so as to effect thereby the formation of a genuine ghee by purely synthetic methods. Accessory food factors like vitamins, sterols and colouring matters may be added to this product to make it perfect as a genuine substitute of ghee.

Turning next to oil-cakes it is needless to emphasise that the utility of oil-cakes not only by themselves but as raw materials for further chemical industries is almost unlimited. Many of them are capable of yielding by suitable methods of extraction, hydrolysis, or other chemical treatments a variety of useful industrial products in the form of fatty and protein foods, as medicinally valuable glucosidic alkaloidal and resinous drugs, as detergents and soap substitutes and as adhesives and glue ghee substitutes besides affording mineral constituents like phosphates and potash salts as rich fertilisers. In fact there is a crying need for a systematic chemical research on the scientific and industrial potentialities of our abundant oil-cakes. It is rather difficult to foresee in full the immense possibilities in this direction. It is permissible to add in this connection that even a fine chemical industry involving a series of amino-acids on the one hand and sterols, phosphatides and related compounds on the other, is possible of establishment by using oil-cakes as starting material.

Coming last to the shells and husks of oil seeds the position regarding the scientific knowledge about them is even more scanty than that of oil-cakes. Many of them contain valuable colouring matters, tannins and carbohydrates and cellulosic materials of various types, besides being rich sources of valuable potash and phosphates in their ashes. At present they are either burnt off as cheap fuel or in rare cases used as adulterants

of doubtful fodder value. The proper industrial exploitation of our oil-seed shells and husks is yet to be thought out. To indicate the possibilities in this direction one may refer to a few that have yielded useful industrial products as a result of systematic scientific research. It is well known that cocoanut shells are rich sources of phenol and acetic acid on their being subjected to destructive distillation. Similarly cashew shell oil which is a bye-product in the cashew industry on the west coast of South India is a rich source of higher phenolic compounds capable of yielding valuable plastic material on suitable treatment. The case of cotton seed hulls is another instance of hidden wealth brought out to light by systematic investigation. The hulls have been shown by the writer to be a very rich source of the valuable chemical substance, *viz.*, furfuraldehyde which is readily optained from it by a simple hydrolytic treatment. The utility of furfuraldehyde in the synthetic plastic industry as well as in the synthetic dyestuff industry is well known. Further the ashes of cotton seed hulls are almost entirely composed of potashes, which are so useful in the fertiliser industry. The hulls also yield a dyestuff which can colour silk or cotton yellow. The case of groundnut shells is very similar to that of cotton seed hulls, and can yield the same products besides pure alpha cellulose. Another direction in which the shells can be utilised is for the preparation of active carbon. It may be said in general, therefore, that a systematic investigation into the scientific and industrial value of the immense quantities of the oil-seed shells and husks is almost an unexplored field full of industrial potentialities and will repay severalfold any amount of investment in the cause of their scientific investigation.

The above are only a few illustrations of the great industrial possibilities arising from a systematic scientific research into the industrial utilisation of our oil seeds and oil-seed products. It is not an exaggeration to say that if properly utilised the raw oil seeds of India may form a starting material capable of yielding a variety of useful finished products not in any way inferior in importance or utility or wealth to the products of the well-established coal-tar industry in India or elsewhere.

In carrying out the above schemes of research it is necessary to emphasise that a number of co-ordinated Provincial institutions, devoted exclusively to locally available oil seeds will be more useful than a centralised institute in any one part of the country. Equally important with these is the provision that will have to be made for the training of skilled artisans and scientific workers for a periodical demonstration and dissemination of the results of research among the interested public through the medium of local vernaculars. It is only by such increase of Indian scientific man-power among the middle class intelligentsia of this country through vernacular education that we can gather the moral and social momentum necessary to raise our country to the vanguard of the progressive nations of the world.

Our greatest hopes, therefore, lie in the new Vegetable Oil Committee which the Government of India have wisely helped to constitute at a most opportune moment in the history of our country.

P. RAMASWAMI AYYAR.

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INFLUENCE OF MERCURY ON INSECT EGGS—PART I

BY B. KRISHNAMURTI AND M. APPANNA

(*Entomological Laboratory, Department of Agriculture, Bangalore*)

THE use of mercury for the protection of stored pulses from insects is an age-old practice in Mysore. Kunhi Kannan (1920) first brought this to the notice of Entomologists in India and elsewhere. He also found that the eggs of the pulse beetle, *Bruchus chinensis*, failed to develop and hatch in the presence of mercury. Larson (1922) made similar tests and confirmed this finding. Dutt and Puri (1929) later found that mercury was equally effective in arresting the multiplication of the grain weevil, *Calandra oryzæ*. Gough (1938) working on the flour beetle, *Tribolium confusum*, showed that mercury had a deleterious effect on the eggs while the grubs remained unaffected. Recently, Wright (1944) carried out observations about the effect of mercury on the eggs of other stored grain insects.

This note embodies in brief the results of a series of experiments conducted here to elucidate certain important details of the influence of mercury on the eggs of stored-grain insects. The aim of these experiments has been to fix the exact quantities of mercury and the methods of using it finally in the case of large-scale storage of grain.

TECHNIQUE

In all the experiments, tall and empty cylindrical jars of known volumes were used. Known quantity, by weight, of mercury was exposed in open paraffin crucibles of uniform dimension and thickness. These were kept at a height of 2·5 cms. above the level of the eggs arranged in a single layer, on filter paper in a petri dish. One hundred fresh eggs were taken for each experiment. The jars were kept covered with air-tight lids. Proper controls under identical conditions were maintained (Fig. C).

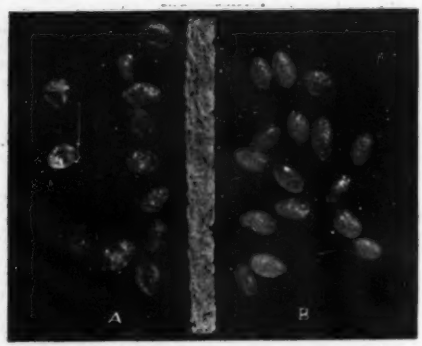
The time allowed to determine the effect of mercury was in each case twice the period taken for the larvæ to hatch out normally from the eggs in the control series. This period was considered necessary in order to allow time for any delayed hatching, in the experimental series.

(1) *Observed results of exposure of the eggs to mercury.*—Eggs (not older than 16 hours) of the following insects were tested: *Corcyra cephalonica*, *Bruchus chinensis*, *Calandra*

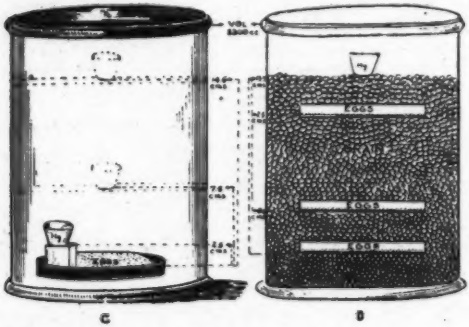
oryzæ, *Tribolium confusum*, *Rhizopertha dominica* and *Sitotroga cerealella*.

In all the experimental series the larvæ failed to hatch from the eggs even after double the period of time normally taken by the eggs to hatch in the controls.

For detailed observations the eggs of *Corcyra cephalonica* and *Bruchus chinensis* alone were chosen.



1. Eggs of *Corcyra cephalonica* exposed to mercury (A) and unexposed (B).



2. Diagram showing the location of mercury and eggs in empty (C) and grain-filled (D) jars.

The eggs of *Corcyra cephalonica*, when exposed to mercury, underwent visible changes externally. Usually 48 hours after exposure, the eggs commenced to shrink; the internal contents also appeared shrunk and pushed to a side. The shining creamy-white colour of the eggs gradually faded. On account of the shrinkage a sort of depression on the exposed surface of the eggs was noticed four days after the first exposure; the colour of the eggs also turned brownish (Fig. A). About 3 per cent. to 6 per cent. of the exposed eggs of *Corcyra cephalonica*, however, did not undergo any perceptible change. The internal contents were found shrunk, but no depression of the surface chorion was visible. Such eggs were kept under observation for a longer period, but in no instance did any larvæ hatch out.

The eggs of *Bruchus chinensis* on exposure to mercury reacted similarly to those of *Corcyra cephalonica*. The eggs, which are usually glued to the grain by the female beetle, became shrunk and flat and gradually turned brown in colour.

Observations on the exact nature of the internal changes in the eggs are still in progress and not quite completed.

(2) *Effective (lethal) dose of mercury for particular volume of empty space.*—A series of trials was set up using different weights of mercury to find out the effective lethal dose for a particular volume of space. Fresh eggs of *Corcyra cephalonica* and *Bruchus chinensis* were used in these series. The technique adopted was the same as before, but the quantity of mercury used was diminished gradually from series to series. Two definite volumes, *viz.*, 3,300 c.c. and 4,000 c.c., were selected for this work. The following table gives the effect of different quantities of mercury on the eggs in particular volumes of empty space.

Quantity of Hg	Effect on eggs	
	3,300 c.c.	4,000 c.c.
1 gm.	Effective	Effective
·5 „	„	„
·1 „	„	„
·05 „	„	„
·03 „	„	Not effective
·02 „	Not effective	„
·01 „	„	„

The lethal dose was assessed to be that minimum weight of mercury which would be effective on the enclosed eggs in a particular volume of space. From the above table it could be seen that ·03 gm. of mercury is the minimum weight effective upto 3,300 c.c. and ·05 gm. upto 4,000 c.c. of empty space.

(3) *The relation between the age and stage of development of eggs and influence of mercury.*—A series of tests with the several post-embryonic stages of the eggs were made but none was found in the least affected. They developed normally into adults in the presence of mercury. The adults also behaved normally and lived their usual lengths of life. Copulation and egg-laying occurred without any visible hindrance.

To determine the exact age at which eggs were affected by mercury, the eggs laid by *Corcyra cephalonica* in wire-gauze oviposition cages were taken and at the time of their exposure to the mercury, they were not older than 16 hours. Different stages of eggs, between 16-48 hours were separately tested. Likewise, the eggs of *Bruchus chinensis*, laid on pulse grains 16 to 72 hours old, were tested.

It was observed from these series of tests that the eggs of *Corcyra cephalonica* less than about 24 hours old, only, were affected by mercury. Eggs older in age were not affected and larvæ later hatched out as in the control series. The eggs of *Bruchus chinensis* less than

about 48 hours old were affected and those older than 48 hours were not affected but hatched into larvæ. It was also observed that there was scarcely any reduction in the percentage of affected eggs as the age of the same advanced; in other words, the percentage of kill, due to exposure to mercury, of the eggs of *Corcyra cephalonica* and *Bruchus chinensis* less than 24 hours and 48 hours old respectively, was uniformly 100, whereas in the case of the eggs older than 24 and 48 hours respectively, it was also uniformly nil to two.

(4) *Mode of penetration of mercury vapour.*—The main object was to find out whether mercury vapour penetrated the egg through the micropyle or through the general surface of the chorion or through both. Eggs of *Corcyra cephalonica* and *Bruchus chinensis* (12 to 16 hours old) were selected and were painted with Euparol of a particular viscosity. In one series of tests only the micropylar end of the eggs was painted with Euparol. In another the entire general surface of the eggs excluding the micropyle was coated with Euparol. Proper controls with eggs painted with Euparol as in the corresponding experimental series, but without mercury, were maintained. In the control series larvæ hatched out in the same manner as in the case of normal and untreated eggs. (This incidentally also proved that Euparol had no ill-effects on the developing eggs.)

In the experimental series it was found that larvæ hatched out from eggs whose micropylar ends only were painted with Euparol whereas the eggs got shrivelled and shrunk in the case of those whose general chorion, excluding micropylar end was coated with Euparol. It appeared clear from this that mercury vapour penetrated the egg through the micropyle and not through the general surface of the chorion.

(5) *Time required for the action of mercury.*—As already stated above, double the period taken by the larvæ to hatch out normally was allowed to test the efficacy of mercury, on the several eggs exposed. Experiments were set up to study the minimum period required by mercury to kill the eggs. Fresh eggs of *Corcyra cephalonica* and *Bruchus chinensis* (12 to 16 hours old) were used in all these experiments. As before, the experiments were conducted in tall, air-tight and empty cylindrical jars (3,300 c.c. and 4,000 c.c.). It was seen that the eggs thus exposed to mercury for 24 hours and later continued in the same jar, but, with the mercury removed, were not at all affected. Eggs exposed to mercury for 48 hours and later removed from out of the jar into the open, became affected.

These experiments were repeated with the mercury placed at different elevations from the eggs spread out on the filter-paper in the petri dish; mercury was placed at 2·5 cms., 7·5 cms. and 14·5 cms. heights from the eggs (Fig. C) in the same jars and the same volumes of space; in each case after about 48 hours the eggs were found affected. It was thus seen that, for the same volume of empty space, the lethal dose of mercury affected the eggs at the bottom, equally effectively whatever the heights at which the mercury was placed.

The minimum period found required for the volatilisation of mercury—the lethal dose—(or for the required vapour pressure in a particular volume of space) and penetration of the vapour into the eggs to kill them in a particular volume of space, was thus about 48 hours.

In all the series of experiments mentioned here, the eggs and mercury were enclosed in the jars simultaneously. This procedure is slightly different from that adopted by other workers, who enclosed, not eggs but adult insects along with mercury. In the latter method there was sufficient interval between the time the adults were put in and the time the eggs were laid by them. During this interval a certain amount of mercury vapour already pervaded the interior of the receptacle. In the present series mercury commenced to volatilise only after the eggs were enclosed.

(6) *Effect of mercury in grain-filled space.*—The lethal dose of mercury found to be effective on the eggs in a particular volume of empty space was enclosed in the same volume of space (3,300 c.c.) filled with grains. Mercury was placed in the paraffin crucibles at the top of the grain. Fresh eggs of *Corcyra cephalonica* were kept at heights of 2·5 cms., 9·5 cms. and 12·5 cms. below the level of mercury (Fig. D). It was found that eggs kept at a height of 2·5 cms. below the level of mercury were affected while those kept lower down hatched out into larvæ. [As already noted in section (5)—in a series of tests with mercury placed at different heights in the same volume of empty space (3,300 c.c.)—it was found that mercury kept at the maximum height of 14·5 cms. above the level of the eggs was found to affect the eggs.]

(7) *Conclusion.*—From these observations it can be concluded—

(i) that mercury acts adversely on eggs of stored grains' insects; larvæ and adults, however, develop normally in its presence;

(ii) that eggs of *Corcyra cephalonica* and *Bruchus chinensis*, only about 24 hours and 48 hours old respectively are affected;

(iii) that ·03 gm. and ·05 gm. of mercury are the minimum lethal doses for 3,300 c.c. and 4,000 c.c. of empty space respectively;

(iv) that mercury vapour penetrates the eggs through the micropyle;

(v) that, in a known empty and enclosed volume of space in which eggs and mercury are kept simultaneously, mercury kills the eggs of *Corcyra cephalonica* and *Bruchus chinensis* 48 hours after exposure;

(vi) that the minimum lethal dose of mercury effective in a particular volume of empty space is not necessarily wholly effective on all the eggs in the same volume of grain-filled space.

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" Mercury as a Control for stored grain pests," *Bul. Ent. Res.*, **1944, 35,** Part 2, 143–60.

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A CHLOROSIS OF PADDY (*ORYZA SATIVA* L.) DUE TO SULPHATE DEFICIENCY

By S. P. Aiyar

(*Agricultural Chemist, Burma, Delhi*)

SINCE 1926 the author has been engaged in studies on the nutritional disorders of the paddy plant and on their correction by manurial treatment. A large volume of work has been carried out but publication was held up in the hope of completing the studies and presenting the work in comprehensive form. Owing to unexpected developments, however, further work on the subject is likely to be indefinitely delayed so that the publication of important facts appears to be desirable. This note deals with the effects of sulphate deficiency.

A chlorosis of paddy, fairly widespread on the Mandalay Agricultural College Farm, was attributed by the author to a possible deficiency of sulphur on the basis of the following observations:—

(1) Experiments on the manuring of paddy on the Farm soil with cyanamide, urea and ammonium bicarbonate during 1926-29 showed that the treated plants were generally chlorotic whereas treatment with ammonium sulphate gave healthy green plants. (2) In the Permanent Manurial Experiment on the Farm, treatment of paddy with sodium nitrate gave chlorotic plants while ammonium sulphate gave normal green plants. (3) There was no trace of chlorosis in the Farm area under the control of the Economic Botanist, Burma, apparently owing to the regular application of Nicifos II on this land, whereas elsewhere on the Farm chlorotic patches were numerous and extensive.

The plants affected by the disorder had the following characteristics:—(1) A general chlorosis with leaves of yellowish green colour, the older leaves being somewhat more greenish than the younger leaves. (2) There was no tendency for the premature death of the older leaves as is usual in cases of nitrogen deficiency. (3) The affected plants were relatively stunted and had fewer tillers and a smaller leaf area than the healthy plants. (4) The chlorotic plants gradually recovered their green colour and remained green and immature at the usual harvest time when the healthy plants had become golden yellow in colour indicating full maturity. (5) Grain formation was not suppressed but the yield of both straw and grain was greatly reduced. (6) The ratio of straw to grain was much narrower in the chlorotic plants than in the healthy plants.

The first experiment to test the effect of sulphate on the chlorotic plants was carried out by the author[1] during the season 1931-32 with the collaboration of the Professor of Agriculture, who provided the necessary facilities. The treatments included magnesium oxide, magnesium chloride and magnesium sulphate with and without ammonium phosphate (free from sulphate). In all cases where sulphate was present the chlorotic plants recovered their normal green colour, made rapid growth and were ripe and ready for harvest along with the healthy plants. On the other hand the plants remained stunted and characteristically immature in all the other treatments. It was thus evident that the chlorosis was not due to a deficiency of nitrogen, phosphate or magnesium. The author's finding that sulphate is the curative agent for the chlorosis was subsequently confirmed by the Mycologist[2] and the Agricultural Chemist,[3] Burma, ~~but neither of them attributed the trouble to sulphur deficiency~~. The latter[3] also expressed a warning against expecting a beneficial effect from applications of sulphur under normal conditions of growth.

As sources of sulphate for the plant the author found that gypsum, powdered sulphur, iron pyrites and the usual sulphate-containing fertilisers were equally effective, and that a rate of application of ten pounds of sulphur per acre in any of these forms was sufficient to cure the trouble and produce the maximum yield in this soil. The treatments produced their effect within three days after application. Under Burma conditions, iron pyrites appeared to be the most suitable source of sulphate as the mineral is found extensively in the country.

Since many areas on the College Farm were found to respond to ammonium sulphate and to superphosphate, comparative tests were carried out in areas of sulphate deficiency to discover whether the action of these fertilizers was due to their characteristic constituents or due to their sulphate content. It was found that treatment with nitrogenous and phosphatic fertilizers gave large increases in yield when they contained sulphate but not when they contained only chloride or nitrate in place of the sulphate. For instance, ammonium ~~sul~~phosphate was far superior to ammonium chloride, urea mixed with calcium sulphate to urea alone, superphosphate to pure monocalcium phosphate, and Nicifos II superior to pure ammonium sulphate. The significance of sulphate in the manuring of paddy has been pointed out by the author[4,5] elsewhere.

The composition of the crop showed the following characteristics:—(1) In the chlorotic plants the straw as well as the grain contained abnormally high percentages of nitrogen compared to the healthy plants, and the yield of crop was found to vary inversely with the nitrogen content (Sen,[6] however, did not find any difference in nitrogen content between the untreated yellow plants and the plants treated with gypsum). The nitrogen test was found to be so sensitive that it could be used to detect the existence of abnormality in the

TABLE I

Yield and Composition of Sulphate-Deficient Paddy after Various Treatments

Season	Treatments	Appearance of crop after treatment	Yield per plot of 180 sq. ft.		Composition of crops at maturity (on dry matter)			
			Straw lb.	Grain lb	Straw		Grain	
					N%	S%	N%	S%
A	Untreated-affected	Chlorotic	6·5	5·3	0·85	0·062	1·22	0·094
	Untreated-healthy	Green	11·5	9·7	0·70	0·122	0·98	0·138
	$MgCl_2$	Chlorotic	5·8	4·9	0·88	0·064	1·28	0·088
	$MgSO_4$	Green	12·3	9·0	0·38	0·133	0·69	0·128
B	Untreated-affected	Chlorotic	6·0	4·6	0·82	0·057	1·32	0·084
	Untreated-healthy	Green	11·4	9·8	0·59	0·118	1·00	0·119
	Gypsum ($CaSO_4$)	"	12·6	10·2	0·38	0·138	0·95	0·135
	Iron pyrites	"	13·1	11·3	0·39	0·129	0·98	0·129
	Sulphur	"	13·5	11·6	0·37	0·127	0·97	0·125
	NH_4Cl	Chlorotic	6·8	5·2	0·85	0·061	1·21	0·081
	$(NH_4)_2SO_4$	Green	11·2	9·5	0·42	0·133	0·97	0·124
	Urea	Chlorotic	7·5	6·2	0·77	0·09	1·28	0·88
	Urea + $CaSO_4$	Green	12·4	10·2	0·41	0·118	0·96	0·119
	$CaH_2P_4O_8$	Chlorotic	6·2	5·8	0·78	0·049	1·26	0·080
	Superphosphate	Green	12·0	9·9	0·40	0·124	1·01	0·115

plant. The test is, however, not specific because nitrogen accumulation has been found to occur also in certain other deficiencies studied by the author.[7] (2) The chlorotic plants contained much less total sulphur than the healthy plants. Microtests with benzidine hydrochloride showed the complete absence of sulphate in the chlorotic plants whereas the healthy plants always showed the presence of sulphate. (3) There was no difference between the chlorotic and the healthy plants in regard to their calcium, magnesium or phosphate contents. (4) The manganese contents of the healthy plants and the sulphate-treated plants were distinctly higher than those of the chlorotic plants. (5) The chlorotic plants contained higher percentages of soluble nitrogen and lower percentages of soluble sugars than the healthy plants.

Selected data are presented in the accompanying table to illustrate the salient features of the work. Only the percentages of nitrogen and sulphur are given as these represent the most important information. Full details will be published shortly.

From the experimental work summarized above it will be seen: (1) that the chlorotic plants contained much less sulphur than the healthy plants; (2) that these chlorotic plants responded to sulphate treatment which led to maximum yields and caused a large increase in sulphur content in the plant; and (3) that sulphate treatment corrected all the abnormalities in the chlorotic plants. It may, therefore, be concluded that the symptoms shown by the chlorotic plants are due to a deficiency of sulphate and that added sulphate acted as a direct nutrient to the plant.

It is necessary to point out that from the data in hand no conclusion can be drawn in regard to the minimum percentage of sulphur in the plant or in the soil which will prevent the chlorosis.

1. "Annual Report of the Professor of Agriculture, Agricultural College, Mandalay, for 1931-32." 2. "Annual Report of the Mycologist, Burma, for 1932-33" page 3. 3. "Report on the Operations of the Department of Agriculture, Burma, for 1933-34" page 14. 4 Aiyar, S. P. *Proc. Nat. Inst. Sciences, India*, 1941, **3**, Part 2, 267. 5. —, *Science and Culture*, 1944, **10** 146-51 6. "Report on the Operations of the Department of Agriculture, Burma, for 1937-38" p. 36. 7 "Annual Report of the Agricultural Chemist, Burma, for 1940-41."

Note—The cost of printing this contribution has been defrayed by a generous grant from the Rockefeller Foundation for the publication of results of scientific work made to us through the kindness of the National Institute of Sciences, India.—*Ed.*

NEW YEAR'S HONOURS

HIS MAJESTY THE KING has been pleased to confer the distinction of Knighthood on Dewan Bahadur A. Lakshmanaswami Mudaliar, Vice-Chancellor, University of Madras, Dr. C. W. B. Normand, Department of Meteorology, Mr. C. C. Inglis, Director, Indian Waterways Experiment Station, Poona, Mr. B. J. Wadia, Vice-Chancellor, Bombay University, and Mr. J. J. Gandhi, of the Tata Iron and Steel Company. Mr. F. C. Minett, Director, Imperial Veterinary Research Institute, Izatnagar, becomes a C.I.E. These distinguished personages are all familiar to readers of *Current Science*. Our heartiest felicitations to them!

447700

ZOOGEOGRAPHICAL DIVISIONS OF THE WESTERN GHATS, AS EVIDENCED BY THE DISTRIBUTION OF HILL-STREAM FISHES

By B. S. Bhimachar

(*Fisheries Officer, Department of Agriculture in Mysore, Bangalore*)

Introduction

THE importance of treating the Western Ghats hill ranges along with the narrow strip of the West Coast as a distinct zoogeographical subdivision of Peninsular India has been recognised by several workers. Blanford in his classical work on the distribution of vertebrates of India designates this area as the Malabar Tract. Based on the distribution of freshwater sponges and polyzoa, Annandale found it necessary to divide Peninsular India into two subdivisions, (*a*) main area consisting of the Peninsula east of Western Ghats, (*b*) Malabar zone including Western Ghats and the West Coast. Prashad,[30] taking into consideration the results of systematic work on various groups of animals, suggested Peninsular India and Ceylon as one of the five divisions of India, with the Malabar zone as a distinct subdivision. A critical study of the literature on the fish fauna of Peninsular India not only indicates the necessity to regard the Western Ghats together with the hill ranges of Ceylon as distinct from the rest of Peninsular India and Ceylon but also points out the need for further dividing Western Ghats into distinct zoogeographical divisions. The facts of distribution which favour such a division and the probable causes that are responsible for the isolation of fishes on the Ghats are recorded in this paper.

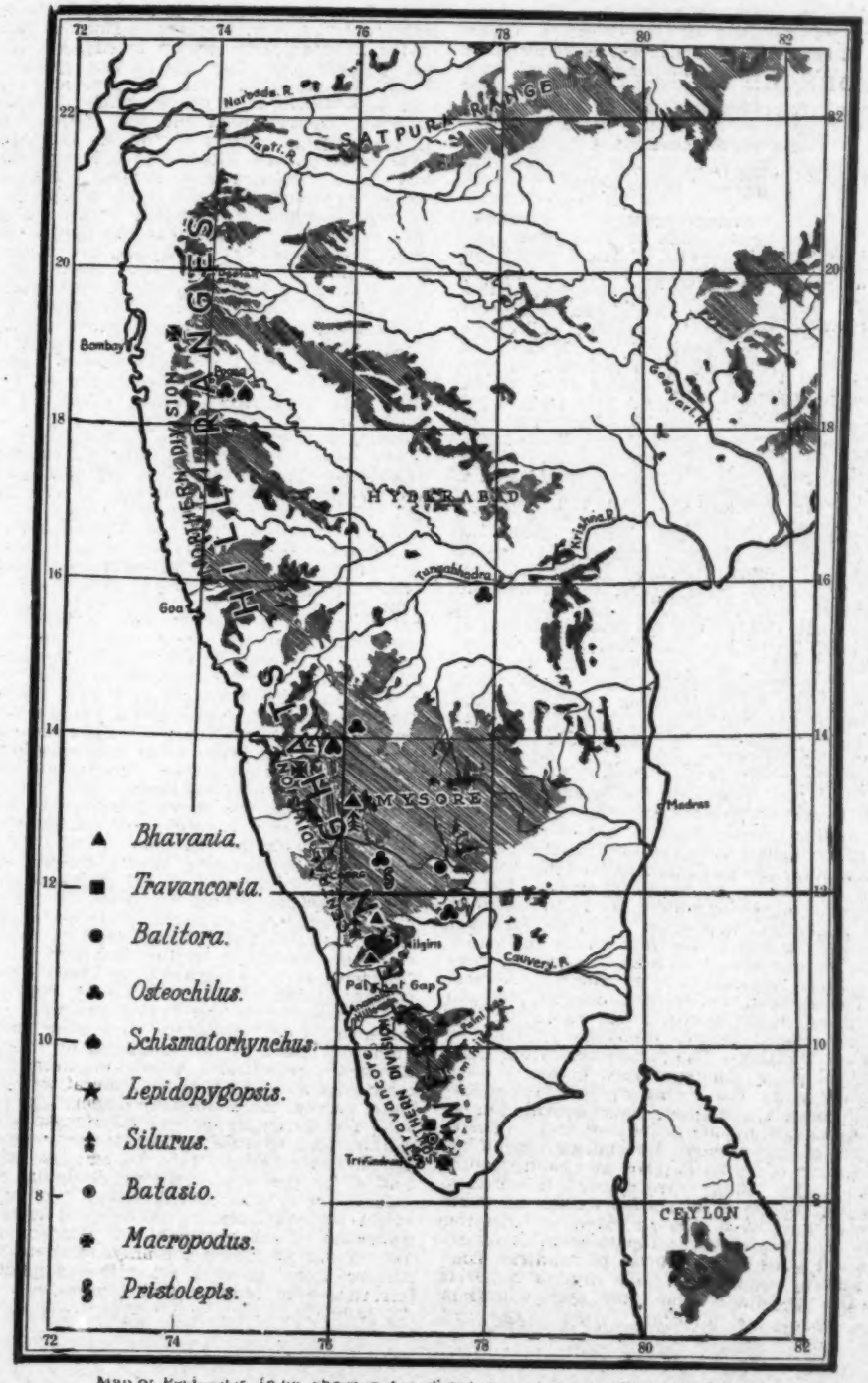
Origin and Evolution of Western Ghats Fish-Fauna

A brief review of the origin, affinities and the evolution of the fish-fauna of the Western Ghats is an essential prerequisite for an attempt to divide the Western Ghats into zoogeographical divisions based on the distribution of fishes. We owe much of our knowledge of the fishes of the Western Ghats to the outstanding researches of Hora on their systematics, affinities and distribution. The two noteworthy features of fishes of the Western Ghats are (i) their close affinity to the fishes of Malay Peninsula and Archipelago and (ii) richness of the endemic forms. Important among the fishes of Eastern affinity on the Ghats are *Balitora, Travancoria, Bhavania, Schismatorhynchus, Thynnichthys, Osteochilus, Silurus, Batasio. Pristolepis* and *Marcopodus*. The close similarity of the fish-fauna of Peninsular India with that of the Malaya region is explained by Hora[18] on the hypothesis that both are derived from a primitive stock of fishes which originated in Southern China. According to Hora freshwater fishes migrated in batches from the original stock in different directions from the place of their origin about the Miocene Period. One such batch migrated southwards along the Indo-Malayan mountains to the region of Malaya Archipelago and another westwards to the region of Eastern Himalayas and from there to Peninsular India. "It seems probable from the records of distribution of certain specialised hill stream fishes that the Satpura trend of elevated country, which during the Miocene and later periods stretched diagonally across India to the Himalayas, permitted the dispersal of the hill stream forms, by a series of river captures or through deflection, from the Eastern Himalayas to the western limit of the Satpuras and the Vindhyas, whence subsequent to the elevation of the Western Ghats, the fauna migrated along the ghats southwards to the hills of the Peninsula" (Hora).[18] Reports on collections of fishes from isolated hill ranges such as Rajmahal hills in Behar, Sihawa range and Bailadila range in C.P. by Hora,[16,17,19] from Hazaribagh district by Das[2] clearly indicate close affinity between fishes of these hill ranges and those on the Western Ghats on the one hand and those in Assam on the other; which supports the view that these hill ranges should have been continuous, forming highway for migration of fishes from east to west during the Miocene period. The richness of the endemic forms is to be attributed to the long isolation of the fish-fauna on the hill ranges of the ghats and the consequent evolution of large number of new forms.

Zoogeographical Divisions of Western Ghats

At the period of the first influx of fishes from the East on to the Western Ghats, it is assumed, that the whole of the Western Ghats, from the Tapti river to the hills of Ceylon, was a continuous range, which permitted the dispersal of fishes throughout the Ghats through a system of river captures due to a differential rise of the Western Ghats. Subsequent to this period there have been geological changes by which parts of this once continuous hill range became isolated into hill groups thus restricting the movements of fishes. Such geological changes are (1) separation of Ceylon from the Peninsula, (2) denudation of the ghats by the upper reaches of the rivers of the Peninsula resulting in the formation of deep river valleys and (3) Deccan Trap eruptions.

Ceylon.—A list of freshwater fishes of Ceylon prepared from the series of articles by Deraniyagala[3–6] shows the basic continuity of the fish-fauna of Ceylon and Peninsular India. As many of the South Indian genera and species of fishes are represented in the fauna of Ceylon, it is clear that Ceylon became separated from India after the migration of these fishes to the island. In Ceylon there are a number of endemic forms such as *Horadandia atukorali* Deraniyagala, a small-sized cyprinoid, an anabantoid *Malpulutta kretseri* Deraniyagala and a few species of *Garra, Rasbora, Barbus, Labeo* and *Clarias* which have evolved as a result of long isolation of the island from the mainland. This is further evidenced by the recent discovery by Deraniyagala of Siwalik mammals in Ceylon which although generically identical with those of India, have been isolated sufficiently long to form separate species.



Map of Peninsular India showing the distribution of certain hill-stream fishes.

Based on the distribution of fishes, three zoogeographical divisions of the Western Ghats can be recognised. For purposes of description they can be termed Northern, Central and Southern Divisions. The Northern Division consists of the Deccan Trap area from the Tapti river up to 16° n. latitude about the level of Goa. The Central Division extends from 16° n. latitude southwards and includes the Malnad parts of Mysore State, Coorg, Wynaad, parts of South Canara district and Nilgiris The Southern Division comprises Anamalai, Palani and Cardamom hills of Travancore.

Northern Division.—The classical work of Sykes on the fishes of Deccan (1841) is in main the basis of our knowledge of the fishes of this division. Fraser[7,8] and Hora and Misra[15,26] have recently described extensive collections of fishes from the environs of Deolali and Poona. Hora and Misra have recorded 50 species from Deolali and 53 species from Poona and a list prepared from these two areas together contains about 70 species. The occurrence of *Schistmatorhynchus* Bleeker and *Mystacoleucus* Gunther is of special significance; besides the Western Ghats, the former is found in the Malaya Archipelago, while the latter is found in Burma, Siam, Malaya, etc., but nowhere else in India. These two genera show the Malayan affinities of the fauna of this part of the Western Ghats (Hora).[26] Suter has reported 17 species from Poona in addition to the number described by Hora and Misra from that area and his record of *Osteochilus nashii* (Day) and *Garra bicorunta* Rao is of zoogeographical interest as it extends the distribution of these species to the Northern Division. Rahimulla and Das[31–33] have reported on the fishes of Hyderabad and the list of fishes of Hyderabad prepared by Rahimulla (manuscript) contains 93 species. The occurrence here of *Thynnichthys* and *Osteochilus* is noteworthy as they represent the eastern element in the fauna of Hyderabad. The majority of fishes in this division have a wide distribution. Further, compared with the Central and Southern Divisions the fish-fauna of Northern Division is noticed to be markedly poor. Except for *Parasilorhynchus prateri* Hora, *Horaichthys setnai* Kulkarni, a species each of *Rasbora, Danio* and *Barbus* and a few others the endemic forms are also few here. Forms of zoogeographical interest such as *Balitora, Bhavania, Travancoria, Pristolepis, Silurus, Batasio* and others which occur lower down on the ghats are absent in this division.

Central Division.—The fish-fauna of the Central Division is comparatively better known. In recent years Rao,[34] Hora[10,12,25] Mukerjee[21] and Bhimachar and Rau[1] have contributed to our knowledge of the fishes of this division. The list of fishes from Mysore and adjoining hill ranges of Nilgiris, Wynaad and Coorg, published by Hora,[25] contains 121 species. From the records of fishes from different parts of Western Ghats it may be estimated that the Central Division presents the richest fish-fauna. There are here certain forms of immense zoogeographical significance. The *Silurus* reported from this division is the same species that is found from Cochin China to Eastern Himalayas. *Balitora brucei* var. *mysorensis* Hora, a variety of the Burman form occurs in Mysore. Hora has pointed out that the three species of *Scaphiodon* found in this division are referable to *Osteochilus*, a genus widely distributed in South Eastern Asia and that *Labeo nukta* Sykes, actually belongs to the Malayan genus *Schismatorhynchus* which was hitherto known only from Sumatra and Borneo. All these except *Schismatorhynchus* and a species of *Osteochilus* which are reported from the Northern Division, are restricted to the Central Division. It is significant that these are absent in the Southern Division. The South Indian Homalopterid genus *Bhavania* occurs both in the Central and Southern Divisions. While classifying the fishes of this division in respect of the different drainages it was noticed that several of Sykes' Deccan species are found in the headwaters of the Tungabhadra river and these are strikingly absent south of this drainage.

Southern Division.—John[27] and Hora and Law[22] have reported on large collections of fishes from Travancore. The northern part of this division, namely, Anamalai hill ranges is still a virgin field. Hora and Law[22] in their article "Freshwater Fish of Travancore", list 76 species. To this list has to be added the new species of Globe fish—*Tetradon* (*Monotretus*) *travancoricus* and the gobioid—*Sicyopterus griseus* (Day) recently reported by Hora and Nair[23] and also Sundara Raj's[35,36] new find *Lepidopygopsis typus* and a species of *Barbus*. It is possible that *Lepidopygopsis* has affinity with the Schizothoracine fishes found in Yunnan. The discovery of a new Homalopterid—*Travancoria jonesi* and a Siluroid—*Batasio travancoria* by Hora,[21,20] deserves special mention as they show close relationship with Eastern fishes. All these except *Sicyopterus* are endemic in this division.

In addition to the above dissimilarity among the fishes of the Central and Southern Divisions, it may further be pointed out that there is abundant endemicity among the fish-fauna of the two areas. Out of 121 species from the Central Division 24 are restricted to that area. If the range of distribution is extended to Deccan also about 33 species are endemic which are absent from the Southern Division. Thirteen out of 81 species in Travancore are endemic there. Hora and Law[22] state "The high endemicity of the Travancore fauna is an evidence of its antiquity and long isolation from the fauna of the mainland of India and adjacent countries. After migration from north-east to south-west, the fauna came to a blind end in the Peninsular region and when, with the formation of the Rajmahal-Garo hill gap and due to other causes, it became isolated and it had sufficient time to blossom out into distinct species while still retaining its family affinities with the parent stock." It may be stated that this remark holds good equally to the fauna of the whole of the Western Ghats. The fauna of Travancore, in particular, has further been isolated from the neighbouring hill ranges of Nilgiris and Mysore.

Discussion

From the foregoing observations it is clear that (1) there is dissimilarity among the fish-fauna of the three divisions of the Western Ghats, (2) the Central and Southern Divisions not merely have large number of fishes of far-eastern affinity but also possess rich endemic forms. An attempt will now be made to account for such geographical differentiation among the fishes of Western Ghats.

It is argued that the geographical differentiation or the dissimilarity between the fishes of the Central and Southern Divisions is due to the presence of a low stretch of land in east to west direction about 16 miles wide and hardly about a thousand feet in elevation known as the Palghat Gap between Nilgiris and Anamalai hills, acting as a barrier for the intermingling of fishes of the two areas, just as the Rajmahal-Garo hill gap which is a barrier between Eastern Himalayan region and Peninsular India. It is well known that a low land like the Palghat gap forms an effective barrier for the intermingling of fishes of the neighbouring hill ranges. With the formation of the Palghat gap the fauna of the Central and Southern Divisions became isolated. In his article on the Dragonflies of Western India, Fraser[9] has referred to the Palghat gap as being an important barrier affecting their distribution. He states, "A study of the fauna on the two sides of the gap has served to show that narrow as it is, it is sufficient to divide the fauna into northern and southern groups". From the distribution of the fishes of Peninsular India it is clear that the Palghat gap must have occurred after the migration of fishes to the extreme south of India on to the Travancore hills. Hence the view expressed by Medlicott and Blanford[28] that "It is also possible that the isolation of the different hill ranges of South India, such as the Shivarai, and the denudation of the Palghat gap south of the Nilgiris, are due in part to ancient marine action of the date as the formation of the Shyadri escarpment" cannot be regarded as correct. It is possible that it is a valley of a former river. It may be stated that whatever may have been the cause of the formation of this gap, it must have been an elevated country at the time of the migration of fishes southwards with the drainage facilitating such a migration.

In respect of geological formations the Northern Division is one which was subjected to violent volcanic eruptions resulting in the formation of Deccan Traps and is formed of basaltic rocks while the Central and Southern Divisions are formed of archæan rocks and are comparatively undisturbed parts except for erosion by the upper reaches of rivers. The poor fish-fauna of the Northern Division is probably due to the fact that considerable amount of their existing fauna must have been destroyed by the volcanic eruptions and that is why Homalopteridæ, *Silurus*, *Batasio*, etc., are not found there. The Central and Southern Divisions, being comparatively stable land masses, appear to have presented a favourable habitat for these fishes to thrive. Further isolation of the hill ranges in these divisions may have been responsible for the evolution of a large number of new forms giving high endemicity to these areas. The rapid speciation in the streams on the hill slopes covered with thick tropical forests in these divisions from Miocene period onwards is not a matter of great surprise as they are subjected to heavy monsoons resulting in varied types of seasonal habitats.

The distribution pattern of fishes on the Western Ghats lends support to the view that the freshwater fishes from the east came to the Western Ghats by a series of successive waves of migration. Roughly four such waves of migration can be recognised. The first batch of fishes migrated to the ghats at a time when the conditions were more or less stable and specialised forms like the Homalopteridæ had not yet evolved. Ceylon, which was not detached from the peninsula at this period, received part of this generalised fauna. The second wave of migration from the east came after the separation of Ceylon from India but before the formation of the Palghat gap and must have been preceded by violent orogenic changes for such specialised hill stream forms as the Schizothoracinæ and the Homalopteridæ had already come into existence by then. This wave of migration spread to the extreme south of the peninsula and we have evidence of it in the present-day fauna. The third wave of migration from the east came after the formation of the Palghat gap and gave a rich fauna to Mysore and the adjoining hill ranges. Forms like *Silurus*, *Schismatorhynchus*, *Osteochilus*, *Balitora* and others must have come with this batch and the Palghat gap appears to have prevented their further migration southwards. It is assumed that about this period the Deccan plateau was about to have volcanic eruptions, the occurrence of which resulted in the elimination of much of the then existing fauna in the Northern Division. The fourth wave probably came after the Deccan Traps had been laid bringing with it forms like *Schismatorhynchus*, *Mystacoleucus*, *Thynnichthys* and *Osteochilus* to the Northern Division.

I am much indebted to Rai Bahadur Dr. S. L. Hora, Director of Fisheries, Bengal, for reading through the manuscript and making valuable suggestions and to Prof. L. Rama Rao, Bangalore, for affording me an opportunity to discuss with him on the Geology of South India.

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MAGNETISM IN RELATION TO STRUCTURE*

AFTER a brief introduction by Prof. Krishnan, the discussion was opened by Sir C. V. Raman, F.R.S., N.L., with the subject "Magnetic Susceptibility of Minerals". He outlined the work that had been carried out in his laboratory for some time. Starting with a tektite from the island of Billiton which proved to be an isotropic glass-like material, successively other minerals have been studied for their magnetic behaviour. An examination of a number of tourmalines showed considerable variations in both susceptibility and anisotropy and the interesting result that there was a close correlation between the two was obtained. Results of even greater theoretical and practical interest were obtained with the minerals iron pyrites and augite.

The iron pyrites used in the investigations were obtained from Nepal in the form of cubes with well-developed faces and of a tin-white colour, instead of the more common golden yellow. The crystals exhibited a brilliant metallic lustre. The susceptibility of the large number of specimens investigated varied from $0{\cdot}2 \times 10^{-6}$ to 190×10^{-6}, the greater part, however, being near the lower value. All the specimens showed a decrease in susceptibility with increase in field strength, the dependance on the field strength being larger, the larger the susceptibility of the specimen. Temperature had apparently no influence nor was there any sign of remanant magnetism.

The behaviour of augite also showed interesting points, the mineral being axially ferromagnetic, anisotropic at low fields and isotropic at high field strengths. While no generalisations could be attempted at this stage, the observations may be considered to open up a fresh field and, as in other cases the magnetic investigation of naturally occurring minerals may throw light where studies with pure substances have failed!

Dr. Mata Prasad, of the Royal Institute of Science, Bombay, next presented a brief resumé of the work carried out by him in collaboration with Dr. S. S. Dharmatti and other students, on "Ionic Susceptibilities and Molecular Configuration". After dealing with the historical background, both in theory and in experiment, which showed clearly the anomalous state of affairs in the correlation of theory with experiment, Dr. Prasad dealt at some length with his work on the sulphur group and in the alkaline earth group. The use of susceptibility data in the assignment of structures was illustrated by taking as examples sulphur monochloride (disulphur dichloride), the selenium analogue and chromium dioxide. It may be mentioned in passing that these results are not quite in accord with structures indicated by the study of other properties, a point to which attention was drawn in the course of the discussion.

An interesting observation pointed out by Dr. Prasad in dealing with the alkaline earth group was the apparent variation in the cationic susceptibility with the nature of the anion when salts of organic acids were studied. There appeared to be a correlation between "the total number of electrons" or the "number of carbon atoms in the molecule" and the increase in cationic susceptibility. Here again, one cannot overlook the possibility that the real abnormality is with the organic ion.

Dr. S. V. Anantakrishnan, of Madras Christian College, Tambaram, followed next with "Diamagnetism and Chemical Bonding". While Pascal's additivity relationship has served a useful purpose in correlating diamagnetic susceptibility with the structure of carbon compounds, as in case of other physical properties, a different method of interpretation is possible correlating susceptibility with molecular structure in the light of present knowledge on the nature of valency. Following the method of Gray and Cruikshank, but using Slater's method for the evaluation of ionic susceptibilities, the paramagnetic contribution through bond formation can be evaluated as 'bond-depressions'. Using these values and the known values of bond moments, diamagnetic susceptibilities of a large number of compounds on calculation gave consistently close agreement with the experimentally determined values. It was also noticed an empirical curve could be drawn correlating bond-order with bond-depressions and, using this curve, the calculated and observed values in the case of resonance structures showed good correlation. By the same procedure the susceptibilities of the ammonium and the nitrate ions could be evaluated and the sum of these gave the molecular susceptibility of ammonium nitrate within the limits of experimental error. It may be remarked that the accuracy of susceptibility determinations preclude any use of this as a means of determining structure, but there is no reason to consider that these data should be interpreted without reference to existing knowledge as to structure and valency.

In the brief discussion that followed, Dr. C. Mahadevan, Dr. Dharmatti, Principal S. Bhagavantam, Prof. T. R. Seshadri, the Chairman and others took part.

S. V. A.

* Report of a discussion at the Joint Annual Meeting of the Indian Academy of Sciences and the National Academy of Sciences, held at Poona, on 28th December 1944, with Professor K. S. Krishnan, F.R.S., in the Chair.

LETTERS TO THE EDITOR

PAGE

Elastic Constants of Quartz. By B. RAMACHANDRA RAO 17

The Distribution of the Mean of Samples from a Rectangular Population. By P. V. KRISHNA IYER 18

New Bands of the HgBr Molecule. By K. R. RAO AND G. V. S. RAMACHANDRA RAO 19

Magnetism of Germanium. By S. RAMACHANDRA RAO 19

A New Method of Designing Packed Columns. By J. SIMON 20

PAGE

A New Anti-Snake-Venom Serum. By A. K. HAZRA, D. C. LAHIRI AND S. S. SOKHEY 20

Thermal Reactions of Iron Pyrites. By B. S. OGALE AND K. R. KRISHNASWAMI .. 21

Influence of Carbohydrate to Nitrogen Ratio on the Formation of Diastase by Aspergillus oryzæ. By A. N. BINDAL AND M. SREENIVASAYA 21

Ergot and Sphacelial Stages on Some Wild Grasses in Mysore. By M. J. THIRUMALACHAR 22

Anomalous Vegetative Reproduction by Cuttings in Ficus religiosa Linn. By G. A. KAPADIA 23

ELASTIC CONSTANTS OF QUARTZ

THE elastic constants of quartz have been determined by Voigt[1] by static methods, and by Atanasoff and Hart[2] by dynamical methods employing high frequencies. Variously oriented quartz plates were used by these authors. In the present investigation, the phenomenon of the diffraction of light by ultrasonic waves set up in liquids has been utilised for detecting the resonant frequencies of the piezoelectrically-driven plates of quartz.

Quartz (point group D_3) has six elastic constants. The velocities of propagation of a sound wave in a direction normal to the face of an X-cut plate are the roots of

$$(C_{11}-\rho c^2)[(C_{66}-\rho c^2)(C_{44}-\rho c^2)-C^2_{14}]=0 \quad .. \quad (1)$$

The linear mode corresponds to a longitudinal vibration which gives intense diffraction patterns if the plates are silvered uniformly and these are used for evaluating C_{11}. The quadratic form represents two more complicated modes one of which can be made to appear when the plates are unsymmetrically silvered. Similarly the velocities in a direction normal to a Y-cut plate are the roots of

$$(C_{66}-\rho c^2)[(C_{11}-\rho c^2)(C_{44}-\rho c^2)-C^2_{14}]=0 \quad .. \quad (2)$$

The linear factor comes out as an independent torsion even when fully silvered plates are used and yields C_{66}. From the relation $C_{66} = (C_{11} - C_{12})/2$, C_{12} may be calculated. The coupled modes corresponding to the quadratic factor in (2) are excited by adopting unsymmetrical silvering. Solving the quadratic factors of (1) and (2), the constants C_{44} and C_{14} are evaluated. For a plate cut with its normal in the YZ plane and making an angle of 135° with the Z axis, the velocities of propagation will be the roots of

$$[\tfrac{1}{2}(C_{44}+C_{66}-2C_{14})-\rho c^2][\tfrac{1}{2}(C_{11}+C_{44}+2C_{14})-\rho c^2] \times [\tfrac{1}{2}(C_{33}+C_{44})-\rho c^2]-\tfrac{1}{4}(C_{13}+C_{44}+C_{14})^2\}=0 \quad .. \quad (3)$$

The quadratic factor contains two modes excited by unsymmetrical silvering and one of them is used for evaluating C_{13}. In evaluating the constant C_{33}, a Z-cut plate is taken and the method of transmission evolved in this laboratory and described in a previous paper[3] is employed. A consideration of the modes left out in the above calculations furnishes two or three additional checks. The results thus obtained have been corrected for the forces arising from the polarization produced by the vibrations as pointed out by Lawson[4] and the corrected values along with those of Voigt (static) and Atanasoff (dynamic) are given below:—

Elastic Constants of Quartz

	Author	Voigt	Atanasoff
C_{11}	86·94	86·82	86·75
C_{12}	6·96	7·09	6·87
C_{44}	57·62	58·23	57·86
C_{13}	15·60	14·38	11·70
C_{33}	105·80	107·45	106·80
C_{14}	17·43	17·15	17·96

Agreement is satisfactory in respect of all the constants except C_{13}. In this case Atanasoff used an orientation which results in a very complicated expression and a large correction. The discrepancy is probably due to this.

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December 11, 1944.

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THE DISTRIBUTION OF THE MEAN OF SAMPLES FROM A RECTANGULAR POPULATION

IRWIN[1] has obtained the distribution of the mean of samples from a rectangular population by using characteristic functions. It has been shown in this note that this distribution can be obtained by using either of the two sets of multiple integrals given below :—

$$\frac{d}{d\bar{x}}\int_0^{n\bar{x}}\int_0^{n\bar{x}-x_1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\bar{x}^{n-1} \quad (1)$$

$$\frac{d}{d\bar{x}}\int_1^{n\bar{x}}\int_0^{n\bar{x}-x_1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left(\bar{x}-\frac{1}{n}\right)^{n-1} \quad (2)$$

$$\frac{d}{d\bar{x}}\int_1^{n\bar{x}}\int_1^{n\bar{x}-x_1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left(\bar{x}-\frac{2}{n}\right)^{n-1} \quad (3)$$

(A)

.....

.....

Same as (1) of (A) (1)

$$\frac{d}{d\bar{x}}\int_0^{1}\int_0^{n\bar{x}-x_1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-\left(\bar{x}-\frac{1}{n}\right)^{n-1}\right] \quad (2)$$

$$\frac{d}{d\bar{x}}\int_0^{1}\int_0^{1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-2\,c_1\left(\bar{x}-\frac{1}{n}\right)^{n-1} + \left(\bar{x}-\frac{2}{n}\right)^{n-1}\right] \quad (3)$$

$$\frac{d}{d\bar{x}}\int_0^{1}\int_0^{1}\int_0^{1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-3\,c_1\left(\bar{x}-\frac{1}{n}\right)^{n-1} + 3\,c_2\left(\bar{x}-\frac{2}{n}\right)^{n-1}-\left(\bar{x}-\frac{3}{n}\right)^{n-1}\right] \quad (4)$$

(B)

.....

$$\frac{d}{d\bar{x}}\int_0^{1}\int_0^{1}\cdots p\text{ times}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-p\,c_1\left(\bar{x}-\frac{1}{n}\right)^{n-1} + p\,c_2\left(\bar{x}-\frac{2}{n}\right)^{n-1}-p\,c_3\left(\bar{x}-\frac{}{n}\right)^{n-1} \cdots (-)^p\left(x-\frac{p}{n}\right)^{n-1}\right]\cdots(p+1)$$

The probability of a sample of size n, with values lying between $x_1, x_1+dx_1;\ x_2, x_2+dx_2;\cdots\cdots x_n, x_n+dx_n$ is

$$dx_1\,dx_2\cdots\cdots dx_n$$

Using (1) of A, the distribution of $\bar{x}=\frac{x_1+x_2\cdots x_n}{n}$ is

$$\frac{n^n}{\Gamma_n}\bar{x}^{n-1}\,dx.$$

But it can be seen that this distribution is valid only so long as $n\bar{x} \leqslant 1$. When $n\bar{x} > 1$ some of the observed values $x_1, x_2, \ldots x_n$ can be > 1 and they are also included in the distribution obtained. Hence the distribution of the mean for the interval 0 to $\frac{1}{n}$ is

$$\frac{n^n}{\Gamma_n}\bar{x}^{n-1}d\bar{x} \quad (C)$$

When $\bar{x}$ lies between $\frac{1}{n}$ and $\frac{2}{n}$, $n\bar{x}$ lies between 1 and 2 and it is possible that one of the n observed values is > 1 and the distribution of $\bar{x}$ corresponding to these values should be subtracted from (C). It can be seen the distribution of $\bar{x}$ when one of the observations is > 1 is given by (2) of (A). As there are ${}_nC_1$ ways of having one of the observations > 1, the distribution of $\bar{x}$ for the interval $\frac{1}{n}$ to $\frac{2}{n}$ is

$$\frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-{}_nC_1\left(\bar{x}-\frac{1}{n}\right)^{n-1}\right]d\bar{x} \quad (D)$$

It may be noted that (D) is also equal to ${}_nC_1\cdot(2)-{}_nC_0\cdot{}_{n-1}C_1\cdot(1)$, where (2) and (1) refer to (B).

When $\bar{x}$ lies between $\frac{2}{n}$ and $\frac{2}{n}$, two of the n observed values can be > 1 and the distribution can be got by subtracting the distribution corresponding to this portion from (D). First we note that when two of the observations are > 1, the distribution is given by (3) of (A). Out of the n observations, the number of combinations having two observations > 1 included in (1) and (2) of (A) is ${}_nC_2$ and $n\ (n-1)$ respectively. Adding them with the proper signs we find that $-\frac{n\,(n-1)}{2}$ sets of observations having two values > 1 are to be subtracted from (D) to have the distribution of $\bar{x}$ in the range $\frac{2}{n}$ to $\frac{3}{n}$.

Hence the distribution of $\bar{x}$ in the interval $\frac{2}{n}$ to $\frac{3}{n}$ is

$$\frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-{}_nC_1\left(\bar{x}-\frac{1}{n}\right)^{n-1} + {}_nC_2\left(\bar{x}-\frac{2}{n}\right)^{n-1}\right]d\bar{x}. \quad (E)$$

It will be seen that (E) is also equal to ${}_nC_2\ (3)-{}_nC_1\cdot{}_{n-2}C_1\cdot(2)+{}_nC_0\cdot{}_{n-1}C_2\ (1)$, where (3), (2) and (1) refer to (B).

When $\bar{x}$ lies between $\frac{3}{n}$ and $\frac{4}{n}$ three of the observed values can be > 1, and the distribution corresponding to these values is to be subtracted from (E) to get the correct distribution for the interval $\frac{3}{n}$ to $\frac{4}{n}$ of $\bar{x}$. As in the previous cases, when three of the observations are > 1, the distribution for such cases is given by (4) of (A). The number of combinations having

three observations > 1 included in (1), (2) and (3) of A is

$${}_nC_3, \frac{n(n-1)(n-2)}{\lfloor 1 \lfloor 2} \text{ and } \frac{n(n-1)(n-2)}{\lfloor 2}$$

respectively. Adding them with the proper signs it will be seen that ${}_nC_3$ samples with three observations in each > 1 are to be subtracted from (E) and the final distribution of $\bar{x}$ for the interval $\frac{3}{n}$ to $\frac{4}{n}$ becomes

$$\frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1} - {}_nC_1\left(\bar{x}-\frac{1}{n}\right)^{n-1} + {}_nC_2\left(\bar{x}-\frac{2}{n}\right)^{n-1} - {}_nC_3\left(\bar{x}-\frac{3}{n}\right)^{n-1}\right] d\bar{x} \qquad (F)$$

As in the previous cases (F) can be shown to be equal to

${}_nC_3\cdot(4) - {}_nC_3\cdot{}_{n-3}C_1\cdot(3) + {}_nC_1\cdot{}_{n-2}C_2\cdot(2) - {}_nC_0\cdot{}_{n-1}C_2\cdot(1)$, where (4), (3), (2) and (1) refer to (B).

The above argument can be extended to the case of $\bar{x}$ lying in the interval $\frac{p}{n}$ and $\frac{p+1}{n}$, p being $< n$. The number of combinations having p observations > 1 to be subtracted from the distribution for the interval $\frac{p-1}{n}$ and $\frac{p}{n}$ is

$${}_nC_p - {}_nC_1\cdot{}_{n-1}C_{p-1} + {}_nC_2\cdot{}_{n-2}C_{p-2} \ldots \ldots + (-)^{p-1}{}_nC_{p-1}\cdot(n-p).$$

This is equal to + or $-\,{}_nC_p$ according as p is odd or even. Hence the distribution for the interval $\frac{p}{n}$ and $\frac{p+1}{n}$ is obtained by subtracting $(-)^{p-1}\,{}_nC_p$ times the distribution of samples having p observations > 1 from the distribution for the preceding interval.

In general the distribution of $\bar{x}$ for the interval $\frac{p}{n}$ to $\frac{p+1}{n}$ is also given by

$${}_nC_p\cdot(p+1) - {}_nC_{p-1}\cdot{}_{n-p}C_1\cdot(p) + {}_nC_{p-2}\cdot{}_{n-p+1}C_2\cdot(p-1) \ldots + (-)^p\,{}_nC_0\cdot{}_{n-1}C_p\cdot(1),$$

where $(p+1)$, (p),... (1) refer to the integrals given in (B).

The above method of approach will lead to the distribution of the means of Type II and I curves which will be useful in getting the distribution of the mean of $Y=\left(1+\frac{T^2}{N-1}\right)$, where T^2 refers to Hotelling's[2] T^2. As the actual expressions for the distribution of Y are complicated they will be dealt with in another communication.

P. V. KRISHNA IYER.

Imperial Agricultural Research Institute,
New Delhi, *July* 12, 1944.

1. Irwin, J. O., *Biometrika*, 1927, **19**, 225. 2. Hotelling, H., *Annals of Math. Stat.*, 1931, **2**, 360.

NEW BANDS OF THE Hg Br MOLECULE

IN the course of a reinvestigation of the band systems of the HgBr molecule, in order to bring them into conformity with those of HgCl, the authors have obtained a new band system in the region λ 2470-λ 2430, consisting of diffuse and headless bands. About thirty bands could be measured and assigned to the three sequences (0,1), (0,0) and (1,0). The intensity distribution gives a narrow Condon Parabola. The following vibrational constants have been determined:—

$$\nu_e = 40720 \qquad w_e' = 166{\cdot}0 \qquad w_e'' = 183{\cdot}0$$
$$x_e'w_e' = 1{\cdot}1 \qquad x_e''w_e'' = 2{\cdot}0$$

The final state of this system appears to be the same as the final state of the class I system of the HgBr bands, studied previously by Wieland[1] and by Sastry.[2] Full details will be published shortly.

K. R. RAO.
G. V. S. RAMACHANDRA RAO.

Andhra University,
Guntur,
November 20, 1944.

1. Wieland, *Helv. Acta. Phys.*, 1929, **2**, 46 and 77. 2. Sastry, *Nat. Inst. Sci. Ind., Proc.*, 1941, **7**, 353.

MAGNETISM OF GERMANIUM

FROM several points of view, germanium is an interesting element. It crystallizes in the diamond structure. But in electrical properties, it behaves like a semiconductor. Unlike diamond, germanium is soft and has a metallic lustre. One would expect these properties to be reflected in the magnetic behaviour of germanium.

This element has been studied by Owen (1912) who obtained $-0{\cdot}12^*$ as its specific susceptibility. A redetermination of the susceptibility seemed desirable since a sample of Hilger's spectroscopic brand was available. Curie's method was adopted, using water as the standard. The element showed a trace of ferromagnetic impurity, for which due correction was made. The average specific susceptibility obtained with two pieces was found to be $-0{\cdot}147$. This gives for the atomic susceptibility the value $-10{\cdot}7$.

Diamond, silicon, germanium and grey tin belong to the same class of elements from the point of view of crystal chemistry. It is obvious, however, that germanium stands unique on account of some of its properties being absent in the other cases.

A calculation of the atomic susceptibility of germanium on the basis of Slater's method, as modified by Angus (1932) gives $-40{\cdot}9$. On the same basis, the ionic susceptibility of Ge++ (which is in $^1S_0$ state) works to $-16{\cdot}8$ while the experimental value for the metal is $-10{\cdot}7$. These results suggest that the metal contains Ge++ ions, with the two 4 p electrons showing evidence of both valence characteristics and metallic bond. That the valence characteristics are predominant and the metallic bond subdued are apparent from the following facts.

Owen (1912) found that when the element is melted, there is a large rise in the diamagnetic susceptibility. In the case of covalent or homopolar combination, the increase of diamagnetism is accompanied by a link depression. On melting, this depression should partly vanish and the valence electrons would evince a larger diamagnetism.

I am indebted to Dr. K. Rangadhama Rao for the specimen of germanium.

Central College,
Bangalore, S. RAMACHANDRA RAO.
January 10, 1945.

* All susceptibility values are given in 10^{-6} unit.

Owen, *Ann. der. Phys.*, 1912, **37**, 657. Angus, *Proc. Roy. Soc.*, 1932, **136**, 569.

A NEW METHOD OF DESIGNING PACKED COLUMNS

PACKED columns have been designed using almost exclusively overall transfer coefficients and overall H.T.Us rather than individual film coefficients and individual H.T.Us. Since the overall transfer coefficients and overall H.T.Us are defined (for distillation) as follows:—

$$\frac{1}{K_G a} = \frac{1}{k_G a} + \frac{m}{k_L a}$$

$$\frac{1}{K_L a} = \frac{1}{k_L a} + \frac{1}{m\, k_G a}$$

$$H.T.U_{OG} = H.T.U_G + H.T.U_L \frac{mG}{L}$$

$$H.T.U_{OL} = H.T.U_L + H.T.U_G \frac{L}{mG}$$

where G = the rate of flow of the vapours in $\frac{lb.\ moles}{hr. \times sq.\ ft.}$

L = the rate of flow of the overflow in $\frac{lb.\ moles}{hr. \times sq.\ ft.}$

m = the slope of the equilibrium curve.

their use for design purposes can only be justified when they are constant. For example this happens to be so (1) when the resistance of one of the films predominates over that of the other, so that the resistance of the second can be neglected, (2) when the value of "m" remains constant. When both the films are controlling, and the vapour-liquid equilibrium curve is not a straight line, then $K_G a$, $K_L a$. $H.T.U_{OG}$ & $H.T.U_{OL}$ are functions of the slope m; and since m is a variable they cannot be used for design purposes. They are, nevertheless, used (incorrectly) as no alternative method of approach has been presented to the Chemical Engineer.

If the reasonable assumption be made that the slope of the equilibrium curve is constant over small distances:—

$$m = \frac{dy_i}{dx_i} = \frac{dy^*}{dx} = \frac{dy}{dx^*},$$

where y_i and x_i are the interfacial compositions in any differential section of a packed column.

y^* is the composition of the vapour in equilibrium with liquid of composition x present in the differential section.

x^* is the composition of the liquid in equilibrium with vapour of composition y present in the same section

then equations can be derived by means of which the height of any packed column can be computed:—

$$h = \frac{G}{k_G a} \underbrace{\int_{y_p}^{y_D} \frac{dy}{(y^* - y)}}_{\leftarrow N_{G_1} \rightarrow} + \frac{L}{k_L a} \underbrace{\int_{y_p^*}^{y_D^*} \frac{dy^*}{(y^* - y)}}_{\leftarrow N_{G_2} \rightarrow} \quad (1)$$

$$h = \frac{G}{k_G a} \underbrace{\int_{x_p}^{x_D} \frac{dx}{(x - x^*)}}_{\leftarrow N_{L_1} \rightarrow} + \frac{L}{k_L a} \underbrace{\int_{x_p^*}^{x_D^*} \frac{dx^*}{(x - x^*)}}_{\leftarrow N_{L_2} \rightarrow} \quad (2)$$

The integrals N_{G_1}, N_{G_2}, N_{L_1} & N_{L_2} can be evaluated graphically. However, if both $k_G a$ & $k_L a$ are unknown, the height can be expressed either in terms of $k_G a$ or $k_L a$. This is done by solving the above as simultaneous equations.

$$h = \frac{G}{k_G a}\left[\frac{N_{G_1} N_{L_1} - N_{G_2} N_{L_2}}{N_{L_1} - N_{G_2}}\right] = \frac{L}{k_L a}\left[\frac{N_{G_1} N_{L_1} - N_{G_2} N_{L_2}}{N_{G_1} - N_{L_2}}\right] \quad (3)$$

Full details of the derivation and applications of the above equations will be published elsewhere.

My thanks are due to Dr. M. A. Govinda Rau, at present Reader in the Alagappa Chettiar College of Technology, University of Madras, for the help that he has given me in this investigation.

Chemical Engineering Section,
Indian Institute of Science,
Bangalore, J. SIMON.
November 29, 1944.

A NEW ANTI-SNAKE-VENOM SERUM

THE anti-snake-venom serum in use in India at present is effective only against the venoms of cobra and Russell's viper. Lamb (1903, 1904, 1905) when he prepared this bivalent serum showed that it did not neutralise the venoms of any snakes other than the two (cobra and Russell's viper) against which it was prepared. The only improvement introduced in recent years has been the concentration of the anti-snake-venom serum (Maitra *et al.*, 1933, and Greval, 1934). Thus we have lacked a remedy against the bite of krait and the saw-scaled viper—two snakes as common as cobra and Russell's viper.

We have been working on the preparation of a polyvalent anti-snake-venom serum which would be effective against the poison of all the four common poisonous snakes of India—cobra, Russell's viper, common krait, and saw-scaled viper. In this we have succeeded and have taken up its manufacture at the Haffkine Institute.

We have also worked out a method for assaying our polyvalent anti-snake-venom serum on the lines of Ipsen's method (1938) sponsored by the League of Nations Permanent Commission on Biological Standardisation. We have assayed four batches of our polyvalent serum and find that 1 ml. of our serum neutralises not less than the following quantities of dried venoms, when the serum along with the venom is injected intravenously into white mice: cobra 0·6 mg.; common krait 0·45 mg.; Russell's viper 0·6 mg.; and saw-scaled viper 0·45 mg.

We are arranging to issue our polyvalent serum in lyophilised form, i.e., preserved by drying from the frozen state. In this form the serum does not require to be stored in a refrigerator. It may be stored in any cool dark place and may even be carried in a haversack

on one's back if an occasion demands it. Even when stored at room temperature, it is expected, it will keep its full potency for ten years or so.

The new polyvalent anti-snake-venom serum thus meets the long-felt need for a serum, effective against all the common poisonous snakes of India, and which can be made available at rural dispensaries and other out-of-the-way places where it is needed and has not so far reached.

Haffkine Institute, Bombay, *January* 11, 1945.

A. K. Hazra.
D. C. Lahiri.
S. S. Sokhey.

Greval, S. D. S., *Ind. Jour. Med. Res.*, 1934, **22**, 365. Ipsen, J., *Bull. Health Org., Leag. Nations*, 1938, **7**, 785. Lamb, G., *Scientific Memoirs by Officers of the Medical and Sanitary Department of the Government of India*, 1903, No. 5. Idem, *Ibid.*, 1904, No. 10. Idem. *Ibid.*, 1905, No. 16. Maitra, G. C., *Ind. Jour. Med. Res.*, 1933, **21**, 2.9.

THERMAL REACTIONS OF IRON PYRITES

These studies were carried out with several samples of iron pyrites some of which were collected in the field while others were obtained in the laboratory by separation and concentration from its mineral associates. The purities of the samples employed, viz., the FeS_2 contents ranged from 90 to 99·9 per cent. Complete analyses of the samples were also done and the nature and extent of the impurities ascertained.

Some important features of the thermal reactions of iron pyrites under various conditions are the following:—

(1) Absorption of oxygen with consequent increase in weight (about 10 per cent.) of the sample and conversion of the combined sulphur into water-soluble sulphate. (2) Liberation of elementary sulphur to the extent of about 25 per cent. of the sulphur content of the pyrites. (3) Formation of the normal as well as of a basic ferric sulphate. (4) Evolution of sulphuric anhydride in appreciable amounts.

The studies were all carried out in all-glass apparatus adopting standard methods of analysis.

Full details concerning the mechanism of the various reactions and also of their industrial utilisation will soon be presented.

Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, *January* 18, 1945.

B. S. Ogale.
K. R. Krishnaswami.

INFLUENCE OF CARBOHYDRATE TO NITROGEN RATIO ON THE FORMATION OF DIASTASE BY *ASPERGILLUS ORYZAE*

Our previous work has shown that the formation of diastase by *Aspergillus oryzæ* is influenced by the character and complexity of the nitrogen employed in the culture medium. Further studies have revealed that the carbohydrate-nitrogen ratio appears to constitute an essential factor in the elaboration of the enzyme. It is generally recognised that starch stimulates the production of the enzyme, but no quantitative data is available in literature. The present study has been undertaken to determine the effect of the addition of varying amounts of starch to a given quantity of nitrogen, on the formation of diastase by *Aspergillus oryzæ*.

The method of culturing the fungus, of making the enzyme extract and of determining the

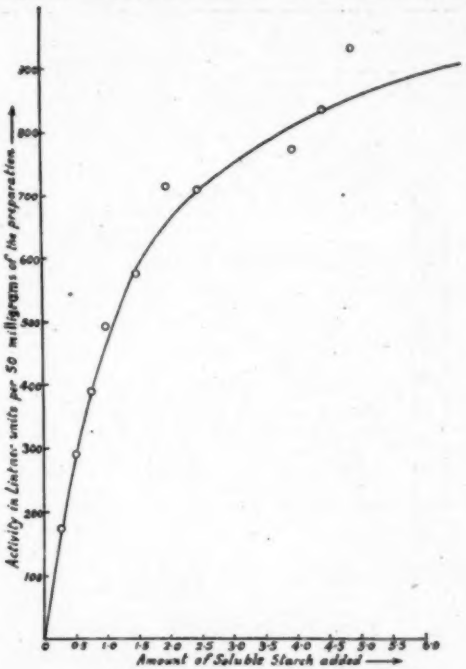

Fig. 1

diastatic activity, are similar to those described in our earlier communications. Finely shredded and acid-digested and purified asbestos was used to provide an inert mat for the growth of the fungus. The basal nutrient solution was composed of:—Peptone (Difco) 60 gms.; potassium dihydrogen phosphate 1 gm.; potassium citrate 1 gm.; magnesium sulphate, $7H_2O$ 1 gm.; ferrous sulphate 0·01 gm.; zinc sulphate 0·01 gm.; calcium chloride 0·5 gm.; water 1 litre.

The medium was constituted as follows:—A given weight (5 gm.) of the asbestos was placed in 250 c.c. conical flasks, moistened with 12·5 c.c. of the nutrient solution (corresponding to 290 mgms. of nitrogen) and treated with graded amounts of soluble starch. The mass was intimately mixed, autoclaved at 20 lbs. for 30 minutes on two successive days. The flasks were then inoculated with a suspension of the spores of the fungus, incubated at 30° C. for three days, the resulting moldy

TABLE I

Reaction Mixture No.	1	2	3	4	5	6	7	8	9	10	11
Starch added in gms.	0,25	0,50	0,75	1.0	1,5	2,0	2,5	3,5	4,0	4,5	5,0
Activity per 50 mgms. of preparation in Lintner units.	173	291	3>8	492	574	711	704	747	760	824	924
Total number of units elaborated by the mixture (in thousands of Lintner units).	4,17	7,10	9,55	12,30	13,96	18,81	20,28	21,96	22,95	26,37	30,49

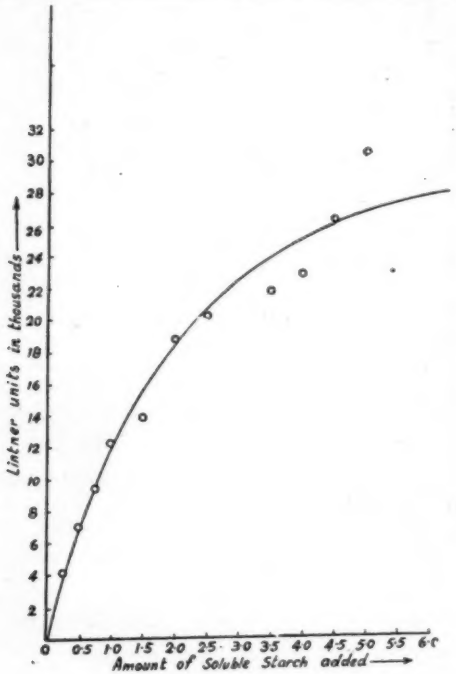

FIG. 2

mass extracted with 25 c.c. of water and the diastatic activity of the extract determined. The results are given in Table I and graphically represented in Figs. 1 and 2. Fig. 1 gives the activity of the preparations from fungi raised on different concentrations of starch; Fig. 2 gives the total quantity of diastase (in Lintner units) elaborated by the different experimental mixtures.

A close study of Table I and the Figures 1 and 2, reveals that with an increase in the proportion of starch, there is a steady increase not only in the purity of the diastase but also in the total quantity of the enzyme formed.

The total quantity of the diastase which is formed in proportion to added starch tends to fall off rapidly after the two per cent. concentration of starch (see Fig. 2). The economic optimum for the ratio of the soluble starch to nitrogen appears to lie somewhere about 7 : 1.

It has been found that starch is completely utilised in all the mixtures so far investigated and the reducing sugar content of the preparations has been found to be insignificant.

Section of Fermentation Technology,
Indian Institute of Science,
Bangalore, A. N. BINDAL.
December 25, 1944. M. SREENIVASAYA.

ERGOT AND *SPHACELIAL* STAGES ON SOME WILD GRASSES IN MYSORE

FURTHER studies on the collections of ergot and *Sphacelial* stages occurring on wild grasses were continued some of which have been found to be of interest. A preliminary account of some of them is presented here. On *Digitaria longiflora* Pers., a common grass in the dry waste lands, ergot and *Sphacelial* stages have been observed. Individual spikelets in the inflorescence are affected. Drops of nectar are secreted in the infected spikelets embedding numerous spores. The spores are hyaline, ovate-ellipsoid, asymmetric to slightly arcuate, tapering at both ends and measuring 11·5-16·5 μ × 3-4·4 μ. The sclerotia that are formed later on are black, ovate to spherical, with a brownish white core and measure up to 2-1·3 mm. in size. They resemble very closely *Claviceps digitariæ* Hansf., recorded on *Digitaria scalaris* by Hansford[1] in Uganda. In spite of the lack of germination stages it is probable that the two belong to one and the same species. *Sphacelia* stage has not been described by Hansford for *Claviceps digitariæ*.

Two other *Sphacelial* stages of some *Claviceps* have been noticed round about Bangalore on *Cymbopogon cæsium* Stapf. and *Heteropogon contortus* Beauv. The presence of the *Sphacelia* is indicated in the field by the presence of *Cerebella* which forms greenish-black folded crusts. The spores of the *Sphacelia* on *Cymbopogon cæsium* are hyaline, ovate-cylindric, rounded at both ends, with two conspicuous vacuoles and measuring 9-12·7 μ × 3·5-4·5 μ. The spores of the *Sphacelia* on *Heteropogon contortus* are also cylindric, hyaline, rounded at both ends and measure 11·5-19 μ × 3·5-5 μ. Development of sclerotia has not been observed.

Department of Botany,
Central College,
Bangalore, M. J. THIRUMALACHAR.
January 5, 1945.

1. Hansford, C. G., *Proc. Linn. Soc.*, 1940-41, 153 Ses., pp. 1-52.

ANOMALOUS VEGETATIVE REPRODUCTION BY CUTTINGS IN *FICUS RELIGIOSA*, LINN.

MANY plants reproduce themselves by vegetative methods, either naturally or artificially. Artificial methods are often resorted to by gardeners, foresters, etc., for the propagation of plants of flowering, ornamental and economic importance.

Of the genus Ficus, *Ficus bengalensis* Linn., *Ficus carica* Linn., *Ficus elestica* Roxb., *Ficus Tsiela* Roxb., etc., are propagated from stem or branch cuttings. So far as the author is aware, *Ficus religiosa* Linn.—a plant which is held in great veneration by the Hindus—is propagated from the seedlings only and not by means of cuttings.

Every year several cuttings of this plant are used as supports to various climbers grown for the class work in the College Botanical Garden. But this year it is found that out of twenty such cuttings only five are found to sprout into leaves and grow in order to produce fresh complete plants. These cuttings were cut down as usual at the end of the month of May and kept for use as supports to climbing plants later on in the monsoon. Remarkable thing about them, this year, is that one of the pieces while lying on the ground gave rise to adventitious roots from one of the cut ends. These roots appear to arise from the region of cambium between the central mass of wood and the peripheral region of the bark. In the beginning of the month of August when these pieces were taken in use, that one which had developed adventitious roots was used after cutting off 18-inch piece from it together with those roots.

The phenomenon of sprouting was noticed after 15 to 20 days in different pieces. This was thought at first to be of temporary nature due to the stimulus given to the buds to sprout, and thereafter to dry up and die. But this did not prove true as these cuttings have struck roots and are able to put forth more of vegetative shoots. The table below gives the circumference just above the ground, height and the number of new shoots on those five cuttings. Mention should be made that these pieces were all branched and some of these branches have dried up while others are alive.

No.	Circumference	Height	No. of new shoots
1	11″	5′—6″	225
2	6·5″	8′—2″	100
3	8″	5′	90
4	7·5″	7′—1″	66
5	8·5″	8′	20

Regeneration is wide-spread among plants. An organ which has been lost is replaced either by formation of a new one in the vicinity of the wound or the outgrowth of one which was in a rudimentary condition. The capacity to form roots is also wide-spread. After roots have developed the stem gives rise to a complete plant either by the unfolding of axillary buds or by development of new growing points to shoots. For all these what is required is a suitable environment.

This year Junagadh had an abnormal weather during the monsoon. Daily several showers of rain continued for nearly two months. There was very little of sunshine during these days, owing to the sky being overcast with clouds. The atmosphere and the soil remained moist all throughout.

This phenomenon may be attributed to this abnormal weather during the monsoon of this year, but what about the development of adventitious roots on one of these cuttings in the dry hot days of the months of May and June? Hence these can only be taken as some abnormal cases.

In this plant, abnormalities have been recorded by Mallik[1] and Singh.[2]

Bahauddin College,
Junagadh, G. A. KAPADIA.
September 26, 1944.

1. Mallik, P. F., "Development of roots from the petiols of *Ficus religiosa* leaf," *Curr Sci.*, 1934, **3**, 105. 2. Singh, T. C. N., "Notes on the Teratology of certain Indian Plants," *Jour. Ind. Bot. Soc.*, 1931, **10**, 135.

CENTENARY OF SIR PATRICK MANSON

THE Centenary of Sir Patric Manson, "the father of tropical medicine" (1844-1922) was marked by a special meeting on Thursday (December 14) at Manson House, Portland Place, of the Royal Society of Tropical Medicine and Hygiene.

Sir Philip Manson-Bahr (his son-in-law) gave an illustrated address on the "Manson saga" and recounted the remarkable career of the young Aberdeen graduate who emigrated to Formosa in 1865 and in 1894 formulated the mosquito-malaria theory, establishing five years later the London School of Tropical Medicine with the aid of Joseph Chamberlain.

This school has suffered much as a result of the war. Most of its activities have been suspended and the Hospital for Tropical Diseases has been destroyed and disbanded. The importance of tropical medicine is now greater than ever and an early rebuilding of the hospital in London becomes more necessary for the benefit of sufferers from tropical disease as a result of the war in the Far East.

It is hoped to found a research scholarship in tropical medicine as an additional memorial. Sir Philip Manson-Bahr appealed for the preservation and extension of Manson's work and Dr. G. Carmichael Low spoke of his dying wish for the establishment of a research scholarship. Other colleagues and friends added their personal testimonies. Manson's diary of original drawings and preparations were exhibited.

REVIEWS

Principles of Physical Geology. By Arthur Holmes. (Thomas Nelson and Sons Ltd., London), 1944. Pp. 532, with 95 plates and 262 text illustrations. Price 30 shillings.

Britain, to whose scientists so much of the pioneer work on physical geology is due, has not in recent years been responsible for the publication of outstanding books on this subject. It was almost as if the fullness of the stratigraphical and igneous record, and the consequent diversity of scenery, notwithstanding the smallness of scale, had led to a complacent acceptance of the wealth of material within, and a neglect of the wonders outside. The book under review has come opportunely to counteract this apparent tendency. It has the catholicity of outlook which is to be expected of an author whose research has for years been connected with the age of the earth. Many will long have had in their possession a small booklet by Professor Holmes, published by Benn for the price of six pence, pennies which were never better spent. The new book is sixty times that price and will be beyond the means of most Indian students, but it is one which every University and Library in the country should have.

It is impossible within a short notice to discuss all the subjects encompassed within the 21 chapters. Part I, of seven chapters, is entitled a preliminary survey, and deals mostly with the materials of the crust. Part II, nine chapters, discusses the external processes responsible for the various types of landscape. Part III, five chapters, is an account of internal processes:—earthquakes, mountain building, plateux and rift valleys, volcanic activity and continental drift. It is not, indeed, the titles which are new, but the manner of presentation, based on the latest work such as gravity determinations in the Caribbean and Dutch East Indies, the coral reef problem, alpine geology, volcanic observations in the island of Hawaii and Professor Holmes' own researches. The impact of original thought is manifest throughout the work.

One of the most striking features of the book is the superb collection of plates and illustrations, taken largely from Europe, North America and South Africa. Many of the photographs are aerial views, from the oblique perspective of which a better impression can be obtained of certain phenomena than from any ground angle. Each chapter contains a recent bibliography.

References to India are relatively few, probably because so much of the work in India is published in official memoirs and records, and photography, particularly from the air, has been neglected. Two problems may be selected for comment. It is possible that the K'un Lun mountains represent the northward overthrust zone separated from the southern Himalaya by the presumed median mass of Tibet (Fig. 199, p. 382), but the recent work of Heim and Gansser indicates that counterthrusts, dipping south, occur south of Kailas and the greater part of the Tibetan plateau. Further, while the idea of isostatic uplift arising from erosion in the Himalaya is not in dispute, the questions of the origin of the river system and the clusters of high peaks in the Karakoram, eastern Kumaon and eastern Nepal is still perhaps unsettled. The recent work of S. L. Hora on the fish faunas of rivers in India and Tibet, and some observations of Griesbach many years ago in the Kumaon, do not support the view of the antecedent drainage of some, at least, of the Himalayan rivers (p. 200), but suggests that it was consequent. Cross warps along an old peninsular N.E.-S.W. grain may possibly, moreover, be involved in the origin of the Kumaon and Nepal clusters of high peaks. These are minor points in a book dealing with the earth as a whole, in which lack of space necessarily prevents a detailed discussion of all the facts.

The type, paper, and reproduction of the plates are a special credit to the publishers after five years of war conditions.

J. B. A.

Inorganic Chemistry. By P. K. Dutt. (H. Chatterjee & Co., Ltd., 19, Shyama Charan De St., Calcutta), 1944. Pp. 245. Price Rs. 2.

In writing this book, the main object of the author has been to present a concise account of elementary principles of inorganic chemistry to meet the needs of students appearing for the Intermediate Examinations of the Indian Universities. It is highly gratifying to note that the author has fully realised his ambition. The first ten chapters deal with the general and theoretical chemistry, the next twelve with non-metals and the last eight chapters are devoted towards a brief description of metals and their compounds. Invariably, at the end of each chapter, a number of questions pertaining to the topics of the chapter are given. A good number of typical chemical problems are also worked out in the text. One special feature of the book is the grouping up of the metallic compounds like nitrates, chlorides, sulphates, etc., instead of the classical method of describing them under the respective metals. The new system evidently removes a good deal of unnecessary taxation on the memory of the student. At the same time it facilitates the remembrance of the more fundamental general characteristics of the metallic compounds. Although the student may find it difficult to follow certain portions of the book at the very first reading, yet this difficulty vanishes after he attends the class lectures. The author should be particularly congratulated on reducing the cost of the book to such a low value as Rs. 2. It is hoped that the students will be greatly benefited by the low cost of this valuable book.

A few suggestions have to be made to improve the book further. Certain topics like arsenic, arsenic compounds, Morley's method of composition of water, have to be dealt with in this book since they are included in the Intermediate syllabus. It is desirable to

include figures for certain important portions like the preparation of ozone, manufacture of iodine, Dumas method for the composition of water, etc. The author has devoted too much of space to describe some obsolete methods of manufactures like the Weldon's and Deacon's processes for the manufacture of chlorine. Actually the modern practice is to manufacture hydrochloric acid from the electrolytic chlorine and not the *vice versa*. The proof-reading must be done more carefully in the next issue and the mistakes that have appeared on the pages 31, 95, 105, 111, 115, 116, 130, 136, 155, 159, 160, 174, 198, 207 and 221 should be avoided. M. R. A.

Thomas Jefferson and the Scientific Trends of His Time. By Charles A. Brownie. (*Chronica Botanica*, Waltham, Mass., U.S.A; and Macmillan & Co., Calcutta), 1943. Pp. 63. Price 1.25 dollars.

Thomas Jefferson, patron-saint of American democracy, author of the Declaration of American Independence drafted by him in 1776, father and founder of the University of Virginia and philosopher, was the third (and twice) President of the United States. That he was also a man of science and naturalist is perhaps not so well known outside the U.S. This scholarly essay by the Dean of American Agricultural Chemists deals with his relationships to the scientific trends, especially those pertaining to Natural History, of his times. As an agriculturist, astronomer, architect, botanist, meteorologist, etc., he considerably influenced subsequent developments in American science and that influence will continue to be felt for a long time. His familiarity with many phases of scientific knowledge which was largely utilitarian is well illustrated by his "Notes on the State of Virginia".

The author of the present contribution has successfully tried to follow the scientific ideas of Jefferson back to their sources and in so doing he has illustrated them by extensive quotations from Jefferson's own writings. As a history of the development of American science, the book is very interesting. M.

The Genera of Uredinales with Citations. By Bisby, G. R. (Imperial Mycological Institute, Kew, England), 1944. Pp. 22. One shilling.

This is a list of all the genera of rusts published since 1801 and up to the end of 1943. Rusts are the most important and interesting among fungi and to a mycologist working in a country whose rust flora is not well known, taxonomy presents many difficulties because of the very large number of genera and species involved. Of the former, the author states that 234 names have so far been proposed.

The genera are arranged in alphabetic order with full citations, dates and the type species whenever possible. No other book has brought together under one cover all the rust genera that have so far been proposed. About 63 names not found in Clements and Shear's *Genera of Fungi*, published in 1931, are cited here although the number of new genera published since that date is only 20.

It is a pity that the author decided not to include comments concerning synonymy and life-cycles. At least those genera which by a majority consent are synonymous, should have been placed in italics (underlined in a mimeographed publication). The author cites *Maseeella* as a monotypic genus. This is an error for Sydow proposed a second species in 1928 and two more have been established by Thirumalachar in 1943. With the exception of Saccardo (Vol. VIII, p. 600), all other mycologists, including the present author, have ignored Rabenhorst's genus *Sarcorhopalum* in *Bot. Zeitung*, 1851, p. 627, the species *S. tubiforme* being found on *Aspidium curvifolium* in the Nilgiris. The reasons for its neglect are not clear.

It is hoped that a new edition in a printed form will soon be published. M.

SCIENCE NOTES AND NEWS

Lady Tata Memorial Trust Scientific Research Scholarships, 1945-46

The Trustees of the Lady Tata Memorial Trust are offering eight scientific Research Scholarships of Rs. 150 each per month for the year 1945-46 commencing from 1st July 1945. *Applicants must be of Indian Nationality and Graduates in Medicine or Science of a recognised University.* The subject of scientific investigation must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications must reach by March 15, 1945. Further particulars can be had from the Secretary of the Trust, "Bombay House," Bruce Street, Fort, Bombay.

At a recent auction in the Argentine, Argentine-grown jute fetched on an average about Rs. 261 per maund, reports the December issue of the *Indian Central Jute Committee Bulletin*. It was the first lot of its kind to be placed on the market, consisting of six bales of 25 kilos each—a kilo equivalent to about a seer. It was regarded rather as a demonstration than as a commercial transaction. The total procedes amounted to Rs. 1,043-4-0, and they were donated to a charitable fund. The jute offered in the sale was obtained from fields which have been planted with it in the islands of Ibicuy in the delta of the Parana River where it empties into the Rio de La Plata Estuary above Buenos Aires. The sale aroused a certain amount of interest as illustrating the possibilities of jute production in the Republic. Not only in this district of Ibicuy, but in others farther north in Missiones and Corrientes

experimental plantings have been made and the National Bank has interested itself to the extent of granting loans to the colonists willing to take part in the movement.

The Mining, Geological and Metallurgical Institute of India held its Thirty-ninth Annual General Meeting in the rooms of the Royal Asiatic Society of Bengal at 11-30 a.m. on Friday, January 12th, 1945. After the Honorary Secretary had read the Annual Report of the Council which showed that the Institute had had a successful year, the new Council was elected. Mr. B. Wilson Haigh, M.I.Chem.E., who, for several years, has been Honorary Secretary of the Dhanbad Branch of the Institute, was elected President for the forthcoming year; *Vice-Presidents*: Mr. L. J. Barraclough, Dr. H. Crookshank and Mr. B. Sen; *Honorary Treasurer*: Dr. H. Crookshank; *Honorary Editor*: Mr. E. J. Bradshaw; *Local Secretaries of Branches*: Dr. C. Forrester, Dhanbad Centre; Mr. J. H. Patterson, Asansol Centre; Dr. J. Sanjana, Jamshedpur Centre; Mr. T. A. Wellsted, C.P. Branch; and Mr. A. Reid, *Honorary Secretary*. In accordance with a new arrangement, the retiring President, Mr. R. A. MacGregor, C.I.E., M.I.Mech.E., Chief Metallurgist to the Government of India, presented his Presidential Address at the end of his term of office. After referring to the tragic loss the Institute had sustained by the death of its Honorary Treasurer, Dr. E. L. G. Clegg, Director of the Geological Survey of India, Mr. MacGregor chose as the subject of his Address, "The Place of the Technical Institutions in the Schemes for Post-War Development of Industry in India".

The Indian Botanical Society has elected the following Office-bearers for the year 1945:— *President*: Dr. N. L. Bor; *Vice-Presidents*: Prof. H. Chaudhuri and Dr. B. P. Pal; *Secretary*: Dr. S. N. Das Gupta; *Treasurer and Business Manager*: Dr. A. C. Joshi; *Elected Members of the Executive Council*: Dr. P. L. Anand, Dr. M. O. P. Iyengar, Prof. G. P. Majumdar, Dr. P. Parija, Prof. M. Sayeed-ud-Din, Prof. T. S. Raghavan, Prof. R. L. Nirula, Dr. T. S. Mahabale, Prof. L. N. Rao, and Prof. F. R. Bharucha; *Editorial Board*: Prof. S. P. Agharkar, Prof. H. Chaudhuri, Prof. M. O. P. Iyengar (Editor-in-Chief), Dr. P. Maheshwari, Dr. A. C. Joshi, Dr. S. N. Das Gupta, and Prof. G. P. Majumdar.

MAGNETIC NOTES

Magnetic conditions during December 1944 were slightly more disturbed than in the previous month. There were 19 *quiet* days, 9 days of *slight* disturbance, 2 days of *moderate* disturbance, and one day of *very great* disturbance, as against 11 quiet days, 19 days of slight disturbance and one day of moderate disturbance during the same month last year.

The quietest day during the month was the 7th and the day of the largest disturbance the 16th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days		
	Slight	Moderate	Very great
1, 3-12, 19-25, 31	2, 13-15, 18, 26, 28-30	17, 27	16

A magnetic storm of great intensity with a sudden commencement was recorded during the month. No magnetic storms occurred during the same month last year.

The mean character figure for the month of December 1944 was 0·48 as against 0·68 for December last year.

M. Panduranga Rao.

We acknowledge with thanks receipt of the following journals:—

"Journal of the Royal Society of Arts," Vol. 92, No. 4678; Vol. 93, No. 4680.

"Journal of Agricultural Research," Vol. 69, Nos. 4, 5 and 6.

"Indian Journal of Agricultural Science," Vol. 13, Pt. 3; Vol. 14, Pt. 2.

"Journal of the Indian Botanical Society," Vol. 23, No. 3.

"Calcutta Review," Vol. 94, No. 1.

"Journal of the Indian Chemical Society," Vol. 21, Nos. 8-9.

"Endeavour," Vol. 3, No. 12.

BOOKS

Your Food. By M. R. Masani. (Messrs. Padma Publications, Ltd., Lakshmi Buildings, Sir Pherozeshah Mehta Road, Fort, Bombay), 1944. Pp. viii + 82. Price Rs. 1.

The Royal Society, 1660-1940. By Sir Henry Lyons. (Cambridge University Press, Bentley Home, 200, Euston Road, London, N.W. 1), 20-11-1944. Pp. 324. Price 25/-.

Flowers in Britain. By L. J. F. Brimble. (Macmillan & Co., St. Martin's St., London, W.C. 2), 1944. Pp. x + 393. Price 12/6.

CORRECTIONS

Vol. 13, No. 12 (December 1944)

Article entitled "Classification of Pre-historic Sites in India"—

P. 303, column 1, line 20: there should be a full stop after the word "Krishna". Then the next sentence should read as "They are also abundant in South India."

P. 306, column 2, line 40: *read* "work" *for* "dork".

P. 307, column 2, line 21: *read* "Wood" *for* "Woo".

Note entitled "Tonic Elongation of Unstriated Muscle"—

P. 311, column 2: the first line should *read* "It could not only be due to" *instead* of "it could not be due to".

Note entitled "The Thermal Decomposition of Mercuric Fulminate"—

P. 315, column, 1, line 16: *for* "result" *read* "results".

P. 315, column 1, line 27: *for* "Hg_2" *read* "Hg_3".

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